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Harding Lawson Associates

A Report Prepared for

National Park Service
Denver Service Center
12795 West Alameda Parkway
P.O. Box 25287
Denver, Colorado 80225

PHASE I PRELIMINARY ASSESSMENT
ORPHAN MINE
GRAND CANYON NATIONAL PARK, ARIZONA

HLA Job No. 22040-002

by

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Senior Geologist

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July 6, 1993

5590-2138254

United States Department of the Interior

NATIONAL PARK SERVICE
GRAND CANYON NATIONAL PARK
P.O. BOX 129
GRAND CANYON, ARIZONA 86023-0129

IN REPLY REFER TO:
A7615(GRCA 8221)

JAN 2 8 1998

Federal Facilities Coordinator
Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, California 94105

Dear Federal Facilities Coordinator:

Enclosed is a copy of the "Phase I Preliminary Assessment (PA) Report" of the Orphan Mine located at Grand Canyon National Park, Arizona. This Preliminary Assessment was conducted by the National Park Service (NPS) to determine if a threat to human health and the environment is imposed by the for limited exposure to NPS employees and visitors to low levels of radionuclides via the air pathway.

Although the HRS pre-score for the site was calculated to be 13.47, well below 28.50, NPS decided to proceed with a more comprehensive study of the issues in an effort to be most protective of human health and the environment. The results of this study, documented in the "Site Inspection and Remediation Risk Assessment Project" report are currently being evaluated by the NPS. Once this report is finalized, we will forward a copy to your office for your review.

Should you have questions or comments, please contact Curt Edlund, Chief of Maintenance, at telephone number 520-638-7730.

Sincerely,

James T. Reynolds
Deputy Superintendent

Enclosures
Phase 1 Preliminary Assessment Report

James_Ellman@contractor .nps.gov
06/22/2007 12:00 PM

To Philip Armstrong/R9/USEPA/US@EPA
cc Shawn_Mulligan@nps.gov
bcc
Subject Fw: Google Earth Image of Orphan Mine Site

Philip: As you requested, attached below is the Google Earth page with a photo of a centrally located portion (the upper mine yard) of the Orphan Mine Site with the latitude and longitude at the bottom of the page. Please confirm with me that you received it.

Jim
----- Forwarded by James Ellman/Contractor/NPS on 06/22/2007 12:53 PM -----

"Mark Gemperline" <MGEMPERLINE@do.usbr.gov>
06/22/2007 12:50 PM CST

To: "Jim Ellman" <James_Ellman@contractor.nps.gov>
cc:
Subject: Google Earth Image

You have been sent a picture of the earth taken with Google Earth (http://earth.google.com).

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(See attached file: GoogleEarth_Image.jpg) GoogleEarth_Image.jpg

Appendix C
References

Facility: NPS-ORPHAN MINE | Record: 10928

Agency: INTERIOR | CERCLIS ID:

Address: P.O. BOX 129

All Facility IDs and Type

ID Type	Number

City: GRAND CANYON | State: AZ | Zip: 86023

EPA Region: 9 | NPL: U | Update Date Revised:

Agency Code: 14 | NFRAP: U | Update Date Added: 11/10/1993

Bureau Code: 17 | POGO: | Date Corrected:

Reporting Mechanism: 103c 103a

Comments: AGENCY REQUESTED ADDITION: URANIUM CONTAINING MINE TAILINGS DISCOVERED AT THE ORPHAN MINE SITE/NORTH RIM; AGENCY REQUESTED

Correction Codes:

CLOSE

Find a Record by Facility Name: NPS-ORPHAN MINE

by State: | **by Docket ID:** | **by Agency:**

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LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

Harding Lawson Associates (HLA) completed a Phase I Preliminary Assessment (PA) of the Orphan Mine in Grand Canyon National Park, Arizona, under the Denver Service Center Task Order No. 1443T0200-92-126. The PA was performed in accordance with "Guidance for Performing Preliminary Assessments under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Guidance Document," dated 1991 (EPA, 1991b). The purpose of the PA is to provide information that will be used to assess if the Orphan Mine site poses a threat to human health and the environment and requires further investigation under the EPA CERCLA site assessment process.

The site is located approximately 1.5 miles northwest of the South Rim Village and consists of an approximately 3-acre upper mine area at the Canyon Rim with numerous abandoned sheds and scattered mine waste and a lower mine area approximately 1000 feet in elevation below the canyon rim with several adits and a large "glory hole". Copper ore was mined from 1906 to 1959. Uranium ore was mined from 1951 until April 1969.

Several radionuclide surveys were performed at the site between 1981 and 1986. Results of these previous surveys suggest that gamma radiation up to 3.0 millirems per hour (mR/hr) emanates from mine waste at the site. Some of the previous investigators recommended that mine waste be reclaimed by filling the main shaft at the upper mine area with the waste at the site, and then capping the shaft with concrete.

The site is on the Coconino Plateau of the Colorado Plateau Geomorphic Province. The shaft from the upper mine area encounters Kaibab Limestone, Coconino Limestone, Hermit Shale, and Supai Sandstone and Shale. Groundwater is expected to occur at a depth greater than 1000 feet below the canyon rim in the Coconino Sandstone. The nearest permanent surface water to the Orphan Mine is the Colorado River, approximately 2 miles and 4600 vertical feet below the upper mine area. The mean annual precipitation at the site is approximately 16 inches occurring principally in the summer and winter seasons, as afternoon thunderstorms

and winter snowfall. Mean maximum temperatures rang from 41 degrees Fahrenheit (^{o}F) in January to 84^{o}F in July. Mean minimum temperatures range from 18^{o}F in January to 54^{o}F in July. Generally, wind flows up and down the canyon from the north-northeast to the south and southeast, from 2 to 4 meters per second.

On September 1 and November 4 and 5, 1992, HLA personnel visited the Orphan Mine to assess current site conditions and interview personnel who previously worked at the mine. The site slopes gently down to the southeast and is primarily covered with grass and bushes. Other features observed at the site include red cinders used as a road base for truck traction, a concrete ore storage pad at the southeast corner, several concrete foundations from former site buildings, a shed containing an air compressor, and the main shaft headframe at the canyon rim. Mine waste was observed scattered around the inside perimeter of the fenced site and outside the fenced area to the west. According to a former mine employee, some ore may have spilled over the edge of the trucks as they circled the site after retrieving ore from the hopper beneath the main shaft headframe.

On September 1, 1992, HLA observed one underground storage tank that reportedly contained diesel at the site. Approximately 5 inches of liquid remained in the UST. During the November site visit, a reconnaissance radionuclide survey was performed at the upper mine area. Background beta plus gamma radiation ranged from 0.01 to 0.04 mR/hr. Beta plus gamma radiation above this background level averaged 5 to 10 mR/hr primarily around the perimeter of the fenced area. Additionally, an area 60 feet west of the mine, outside the fenced area, had beta plus gamma radiation readings above the background level. The radiation readings were taken on individual rocks at the ground surface and decreased rapidly to background conditions a few inches away from the rock. HLA observed the lower mine area from Maricopa Point. Features visible were a large "glory hole" and remnants of the aerial tramway that led from the upper mine area to the lower mine area.

HLA evaluated the groundwater pathway, surface water pathway, soil exposure pathway, and air pathway, in accordance with the PA guidance document, to assess potential human and

ecological exposures to contaminants from the site. These pathways were evaluated within a 4-mile radius of the site and for 15 miles downstream of the site on the Colorado River. No active wells were identified within a 4-mile radius of the site; therefore, the groundwater pathway was not scored and part of the PA.

The potential for chemical migration from site sources to intermittent perennial surface water bodies is considered low. Runoff from the upper mine area flows away from the canyon and is presumably lost to evaporation and ground infiltration. Runoff from the lower mine area is toward Horn Creek, an intermittent tributary to the Colorado River. No drinking water sources were identified within 15 miles downstream of the lower mine area on Horn Creek or the Colorado River. However, the Colorado River is used as a recreational fishery.

Target receptors considered for the soil exposure pathway are workers, residents, and people attending schools and daycare centers within 1 mile of the site, and terrestrial sensitive environments. The potential threat associated with the soil exposure pathway is considered low because there are no residents, schools, or regularly present workers within 1 mile of the site. However, the site is considered a terrestrial sensitive environment under this pathway because it is within the Grand Canyon National Park.

Radionuclides and other metals that may be present in surface soil on or near the site could migrate from the site via the air pathway. Elevated beta and gamma radiation release to the air are suspected based on previous radionuclide surveys. Targets receptors considered under the air pathway include residents, students, and worker population within 4 miles of the site, and sensitive ecological environments within 1/2 mile of the site.

The overall site score using the PA scoresheets and data from the four exposure pathways was 13.47. According to EPA guidance, sites (such as the Orphan Mine) that score less than 28.50 receive a recommendation for no further remedial action under the CERCLA site assessment process.

HLA recommends that no one should enter the mine tunnels unless the radiation levels are lowered. If the GCNP wishes to open the upper site area for public access site reclamation

should at least include mitigating physical site hazards. Based on the results of the PA, HLA is unable to assess if visitors and park employees direct contact with the site waste would cause adverse health effects. If the site is opened, either a baseline risk assessment should be performed to assess health effects resulting from direct exposure or the site should be reclaimed to background conditions. For either scenario, the extent of mine waste at the upper and lower mine areas and the magnitude of radiation should be assessed. The investigation and UST closure would cost approximately $43,098. A baseline risk assessment would cost approximately $24,922. Since the site is not fully characterized, HLA is unable to present cost projections for site reclamation.

HLA recommends that the identified underground storage tank be closed in accordance with the Arizona Department of Environmental Quality regulations. This would cost approximately $10,500.

1.0 INTRODUCTION

This Phase I Preliminary Assessment (PA) of the Orphan Mine in Grand Canyon National Park (GCNP), Arizona, was prepared by Harding Lawson Associates (HLA) to satisfy the requirements of Task Order 1443T0200-92-126 authorized by the National Park Service (NPS) Denver Services Center (DSC) on September 30, 1992. This PA has been prepared in accordance with (1) the Federal Agency Hazardous Waste Compliance Docket Reference Manual (EPA, 1991a), and (2) Guidance for Performing Preliminary Assessments Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA, 1991b).

The purpose of a PA is to provide information that will be used to distinguish sites that pose little or no threat to human health and the environment from sites that require further investigation under EPA's CERCLA site assessment process. The PA also identifies sites requiring emergency response actions. The structure of the PA follows the structure of the Hazard Ranking System (HRS) model (55 FR 51532, December 14, 1990), the mechanism used by EPA to evaluate sites for inclusion on the National Priorities List (NPL). By definition, the PA is a limited-scope investigation that emphasizes gathering information on people and resources that might be threatened by chemicals migrating from the site. The PA generally involves a site reconnaissance without collection of environmental samples (EPA, 1991b).

This PA is the result of observations made during a site reconnaissance on September 1 and November 4 and 5, 1992, and interviews of NPS and state agency personnel conducted by HLA.

The objectives of the PA for the Orphan Mine are to:

1. Provide physical descriptions of potential sources of hazardous substances associated with the site.

2. Identify human and environmental target receptors associated with the four pathways: groundwater, surface water, soil exposure, and air.

3. Evaluate the likelihood of hazardous substances migration from the site via groundwater, surface water, and air.

4. Evaluate the likelihood for direct contact with soil by human and environmental targets.

5. Determine whether CERCLA a Site Inspection (SI) is warranted.

2.0 SITE DESCRIPTION

This section provides general site descriptive information including the site location, site history, previous investigations, geology, surface and subsurface hydrology, and meteorology.

2.1 Site Location And Description

The Orphan Mine is located in GCNP midway between Powell Memorial and Maricopa Point, approximately 1 1/2 miles northwest of South Rim Village, Coconino County, Arizona (Plate 1). The site lies within Township 31 North, Range 2 East, Section 14 (Plate 2). The site is comprised by an upper mine area at the canyon rim and a lower mine area approximately 1000 feet in elevation below the canyon rim. Access to the site is by West Rim Drive from South Rim Village: The upper mine area is surrounded by a 6-foot high cyclone fence on the west, east, and south sides, and the canyon rim on the north side. Access to the site is through a locked gate. The lower mine area is accessible only by foot along the base of the Coconino Sandstone from the Bright Angel Trail.

The upper mine is an approximately 3-acre relatively flat area surrounded by a cyclone fence and the Canyon rim. The majority of this area is covered with grass, bushes, and aggregate materials. Several abandoned sheds and concrete/asphalt pads exist throughout the site. The main adit headframe and ore hopper are located at the north edge of the site.

The lower mine is an approximately 1-acre steeply sloping area approximately 1000 feet in elevation below the canyon rim. A few abandoned sheds and a large mining subsidence hole (glory hole) connected to underground adits and shafts are visible at the lower mine area. Additionally, remnants remain of a tramway to the upper mine area.

2.2 Site History

Daniel L. Hogan and Henry Ward filed the claim for copper mining in 1893 at the lower mine area and patented it in 1906. Copper mining occurred at the lower mine area at various times between 1906 and 1959. The claim was acquired by Madeline Jacobs in 1946 (Magleby, 1961). As a result of the discovery of uranium at the site in 1951, the mineral rights

were leased in 1953. The rights were later acquired by a subsidiary of Western Gold and Uranium Inc., later renamed Western Equities, Inc. (Hom, 1986).

In 1956, Western Gold built an aerial tramway from the lower adit area to the rim to facilitate removal of uranium ore. From 1956 to 1959, ore production averaged 1,000 tons per month of 1 percent uraninite (U_3O_8).

In 1959, a shaft was driven from the top of the tramway to 1600 feet below the canyon rim to the lower adits to haul ore, men, and materials to and from the lower mine workings (Hom, 1986). Production in 1960 averaged 6400 tons per month of 0.3 percent U_3O_8 (Hom, 1986). Most of the ore was trucked to the Tuba City, Arizona mill for processing. Some ore was also shipped by railroad to a uranium mill in Grants, New Mexico (Hom, 1986).

In 1961, the permitted mining limit for ore deposits in GCNP was reached. Under public law of 1962, additional ore could be mined until 1987, at which time the site would become NPS property (Hom, 1986).

The Cotter Corporation purchased the mine in 1967 and continued mining until April 1969, at which time all mining operations at the site ceased (Hom, 1986). In February 1981, Republic Mining Enterprises purchased the Orphan Mine (Hom, 1986). In 1987 the GCNP acquired the site.

2.3 Previous Investigations

Results of several radionuclide surveys in the GCNP files were reviewed by HLA. Throughout the 1980s, Arizona State University students performed radionuclide surveys of the Orphan Mine and other areas of the GCNP. These surveys were performed as class exercises, and the objectives, results, and conclusions were not clearly presented in the reports and did not contain appropriate quality assurance. Therefore, the results will not be considered as background information.

In 1981, the U.S. Department of Labor Mine Safety and Health Administration (MSHA) prepared a report entitled, "Report of Radiation Survey, Orphan Mine, Grand Canyon National

Park, Arizona," dated November 5 through 7, 1981 (Day, 1981). The survey was performed in response to requests by the NPS for information regarding radiation and the current status of underground workings at the site. On November 5, 1981, gamma radiation up to 3.0 millirems per hour (mR/hr) was measured at the main shaft area of the upper mine workings. In the middle of the upper mine workings near the guard's home site, 0.05 to 0.10 mR/hr of gamma radiation was measured. On November 6, 1981, an underground survey was conducted. At approximately 700 feet below the canyon rim, several measurements were taken. The ventilation airflow volume was 7800 cubic feet per minute; temperature was 3 degrees Fahrenheit, with the relative humidity of 82 percent. Detector tubes indicated no carbon monoxide was present. Bistable air samples indicated 500 parts per million (ppm) carbon dioxide, 0.0 ppm carbon monoxide, and 20.91 percent oxygen. Radon daughter samples were at 49.8 WL. At 1500 feet below the rim, at the shaft bottom, two radon daughter samples contained 54.8 and 60.6 WL. Gamma radiation measurements indicated 4 to 5 mR/hr. Based on the results of the survey, the MSHA recommended that no one enter the mine unless work is done to lower the radiation levels. Additionally, they recommended that since the guard's home site area was exposed to gamma measurements of 0.05 to 0.10 mR/hr, which would exceed the maximum allowable 0.17 rem dose exposure per year, that the guard home site be moved away from the mine dump areas. The MSHA did not specify the basis for the 0.17 rem exposure standard. The MSHA did not present a site plan indicating measurement locations, nor did they tabulate the data.

On March 3, 1986, Landmark Reclamation (Landmark, 1986) performed a radiological survey utilizing an Eberline PRM-7 Microrem meter. Landmark Reclamations' assessment was performed to assess the extent and magnitude of radiological contamination in an around the upper mine area. The assessment was included in a proposal for site reclamation. Their surveys were performed on a 25-foot grid over the yard area taking measurements with the meter at waist height. Additionally, they collected soil samples from six locations at various depths throughout the mine and surrounding area to assess uranium content in the soil to correlate

between total gamma readings and soil uranium content. The soil sample results were not presented in the Landmark Reclamation report. Radionuclide survey results ranged from 0.08 to 0.9 mR/h. The highest readings were measured at the southeast corner of the upper mine area near the concrete ore pad and at the upper mine shaft opening. Plate 3 presents results of the Landmark Reclamation radionuclide survey. Based on the results of the assessment, and the high visitor use at this area, Landmark Reclamation recommended that the residual radioactive material be excavated from the site and disposed down the 1600-foot shaft at the rim and the remaining material buried at an offsite location. Additionally, they recommended that the shaft opening, once the material was placed inside, be sealed to prevent radon gas from emanating to the surface. They further recommended that the tramway structure and lower mine bunk house area and residual mining equipment be removed. Their final recommendations included recontouring the site and planting native vegetation.

In June 1986, the U.S. Department of Interior Bureau of Land Management (BLM) completed a reclamation report for the Orphan Mine. The results of the BLM radiological survey at the upper and lower mine area using an Eberline PRM-7 Microrem meter at waist height had eight readings ranging from 0.11 to 3.2 mR/hr. The highest reading of 3.2 mR/hr was in an adit at the lower mine workings. The BLM report did not contain a legible site plan indicating reading locations. The BLM recommended that the material with highest radiation readings in and around the fenced upper mine area be deposited into the mine shaft. After the material is placed in the shaft, they recommended that the shaft be sealed with 4-foot concrete cap, and then covered with 2 feet of top soil. At the lower mine workings, the BLM recommended that a heavy-duty chain-link fence be constructed around the mining subsidence hole to prevent wildlife and hikers from falling in. The BLM recommended that all adits and raises be sealed by exploding dynamite to prevent entry into the underground mine workings and to prevent build-up of naturally occurring spring water in the mine adits. The BLM concluded that reclamation of the Orphan Mine site should be implemented by the NPS to minimize residual hazards to park visitors from the past mining operation. However, they stated

that reclamation of the site need not be the highest priority because of the short radiological exposure time experienced by park visitors.

2.4 Geology

The site is on the Coconino Plateau of the Colorado Plateau geomorphic province. The upper mine working area is on recent soils of the Kaibab Formation Limestone. The shaft from the upper mine area encounters Paleozoic age Kaibab Limestone, the Toroweap Formation, Coconino Sandstone, Hermit Shale, and the Supai Formation (sandstone and shale) (Gornitz et al., 1970). The ore body is located in a breccia pipe filled with rock fragments from the Coconino Sandstone and angular siltstone, shale, and limestone breccia from the Supai and Hermit Formations. These rocks collapsed into a solution cavity formed in the Redwall Limestone. The primary ore was uraninite, pyrite, chalcocite, tennantite, chalcopyrite, and galena (Gointz et al., 1970).

2.5 Surface And Subsurface Hydrology

The nearest permanent surface water feature to the Orphan Mine is the Colorado River, which forms the base of the Grand Canyon approximately 2 overland miles and 4600 vertical feet below the upper mine area. The Colorado River flows westward through GCNP and Lake Mead National Recreation Area before turning southwestward and eventually emptying into the Gulf of California.

Based on a review of the U.S. Geological Survey topographic map (1962) and observations made during the site visits, surface water runoff from the upper mine area flows southeast off of the site and away from the canyon. Runoff water from the upper mine area would probably be lost to evaporation and ground infiltration. Seepage and runoff from the lower mine area flows toward Horn Creek, an intermittent tributary to the Colorado River (Plate 4).

Groundwater in the Coconino Plateau originates in the San Francisco Peaks/Williams areas, the Aubrey Cliffs area, and the highlands surrounding South Rim Village. Water from precipitation in the highlands near South Rim Village percolates through a series of permeable

and semi-permeable strata creating a number of perched water zones. Most of these zones yield little water for development. However, at elevations approximately 1000 feet below the surface of the rim, the Coconino Sandstone, where underlain by the Hermit Shale, may provide a low yield of water to wells. The saturated thickness of the perched aquifer depends on the relative permeability of Hermit Shale, amount of precipitation, and any local geologic structural influences. Groundwater perched on the Hermit moves radially until finally percolating through the Hermit and the Redwall Limestone into the Muav Limestone (Johnson, no date).

2.6 Meteorology

The following climatological data for the South Rim of GCNP was summarized from the Final Environmental Impact Statement, GCNP (NPS, no date). Mean annual precipitation is approximately 16 inches. Almost equal amounts of precipitation are received in the winter and summer seasons; spring and fall are relatively dry. Precipitation events in the summer occur when afternoon thunderstorms form as a result of solar heating of the canyon walls. In the winter season, middle latitude storms carrying Pacific moisture propagate eastward depositing snow on the South Rim. Generally, the winter storms are light to moderate in intensity; however, occasionally severe winter storms will pass through the area.

The mean maximum temperature ranges from 41 degrees Fahrenheit (^{o}F) in January to 84^{o}F in July. The mean annual temperature is 49^{o}F. Mean minimum temperatures range from 18^{o}F in January to 54^{o}F in July. Generally, temperatures increase with decreasing elevation in the canyon.

As a rule, the wind flows up and down the canyon from north-northeast to the south and south-southwest direction which reverses diurnally. Wind speeds are typically low and range from 2 to 4 meters per second. Night-time inversions are common in the canyon.

3.0 WASTE CHARACTERISTICS

The initial step in evaluating waste characteristics for the PA is to identify sources at the site. EPA guidance (1991b) defines a source as an area where a hazardous substance may have been deposited, stored, disposed, or placed. Soil that may have become contaminated as a result of hazardous substance migration is also considered a source. This section discusses the information gathered during the site visits, and the rationale for source identification and evaluation. Also discussed in this section are applicable UST, mine remediation, and radiation exposure regulations. Plate 3 illustrates the site plan. Appendix A presents the PA information form, Appendix B presents the PA Scoresheets, and Appendix C presents site photographs.

3.1 Site Visit

On September 1 and November 4 and 5, 1992, HLA personnel visited the Orphan Mine to assess current site conditions. Prior to arriving at the site, HLA personnel interviewed a former mine employee who provided information on past operations. The former mine employee stated that waste rock and lesser amounts of ore would accumulate around the perimeter of the site as the mine trucks exited the site hauling the ore to the offsite mills (GCNP, 1992).

The site slopes gently down to the southeast. The majority of the site was covered with grasses and shrubs. Red cinder was used as a road base for truck traction and also covered much of the site. The concrete ore pad was observed at the southeast corner of the upper mine area. Several concrete foundations from former site buildings were observed in the center of the site. A shed containing an old compressor was observed at the northeast corner of the site adjacent to the canyon rim. A concrete pad and asphalt pad at the west edge of the site was also observed. The former mine employee stated that these pads were used as foundations for a mechanic shop and a parking area.

One underground storage tank (UST) was observed in the middle of the site. The UST was approximately 5-foot-wide by 13-foot-long and contained approximately 5 inches of liquid. The former mine employee stated that the UST was used to store diesel fuel. He stated that a

UST

second UST was used adjacent to a concrete pad just north of the center of the site (GCNP, 1992). HLA was unable to assess if the UST still exists.

During the site visit, a reconnaissance radionuclide survey was performed at the upper mine area to assess distribution of radioactive ore and waste rock. Radiation was randomly measured throughout the fenced area and west of the fenced area. Background beta plus gamma radiation outside the fenced area at the southwest corner ranged from 0.01 to 0.04 mR/hr. Beta plus gamma radiation above this background level averaging 5 to 10 mR/hr was observed primarily around the perimeter of the fenced area. Small accumulations of rock overburden and possible ore were observed around the inside perimeter of the fenced area, where the former employee had indicated that trucks had driven. Approximately 60 feet west of the mine outside the fenced area, radiation was detected above the background level at a 200-square-foot area that appeared to be where ore trucks had parked. The radiation readings were also taken above individual rocks at the ground surface. The readings rapidly decreased to background conditions within a few inches from the rocks.

From Maricopa Point east of the upper mine area, HLA observed the lower mine area. A large "glory hole" was observed near the base of the aerial tramway that was formerly used during the mining operation. Seepage water reportedly emanates from a small diameter pipe at the lower mine area (Hom, 1986).

3.2 Source Evaluation

Potential sources of contamination at the Orphan Mine were evaluated according to PA scoring guidance (EPA, 1991b), presented in Appendix B. Site sources were delineated as follows: (1) contaminated soil; (2) the underground storage tank (UST) observed during the site visit; and (3) the UST allegedly present that was not observed at the time of the site visit.

Areas of soil potentially contaminated by radionuclides and metals were conservatively estimated to include (1) the entire three-acre fenced portion of the upper mine area; (2) one additional acre where contaminated soil may be present outside of the fence at the upper mine

area; and (3) two acres at the lower mine area where ore and waste rock may have been deposited on the slope. The source of radionuclides at the site is uraninite in the mined ore and waste rock. The ore contained 0.3 percent to 1.0 percent uraninite (Hom, 1986). The waste rock would probably contain lower concentrations of uraninite than the ore. Uraninite (U308) is water soluble in an oxidizing environment.

The UST that was observed during the site visit and the second UST that is allegedly present were also identified as sources. The observed UST was reportedly used to store diesel fuel; contents of the second UST are not known. Tank capacity for each UST was estimated as 5000 gallons.

3.3 Regulatory Framework

The regulatory framework for the site USTs, mine site remediation, and worker and public exposure to radiation are as follows.

Underground Storage Tanks

The State of Arizona through the Arizona Department of Environmental Quality (ADEQ) has regulatory authority for the registration and closure of USTs in accordance with Federal Regulation 40 CFR 280 and Arizona Revised Statute 49, Chapter 6. The regulatory proceedings developed by ADEQ require that USTs be registered prior to removal. The ADEQ requires visual inspection and soil sampling and analysis to determine if the USTs have leaked. Affected soils above the suggested soil cleanup levels will need to be removed and properly disposed or remediated.

Mine Site Remediation

There are no established standards for remediation of uranium mine sites. The U.S. Environmental Protection Agency (EPA) established "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites" (40 CFR 192 Subpart B). These standards may be appropriate for the Orphan Mine site. The standards for remedial actions at inactive uranium processing sites state:

The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than:

- Five pCi/g [picocuries per gram] averaged over the first 15 cm [centimeters] of soil below the surface, and
- 15 pCi/g averaged over a 15 cm thick layer of soil more than 15 cm below the surface.

Although these standards are not directly applicable to the Orphan Mine site, they may serve as target remediation goals for any subsequent soil excavation at the site.

Radiation Exposure

No limits have been established for human exposure to radiation from inactive uranium mine sites. To establish exposure criteria for the Orphan Mine site, standards developed for other locations were considered. For on-site worker exposure (personnel involved in investigation or remediation), the most appropriate standards are established by the Occupational Health and Safety Administration (OSHA) for personnel exposure in restricted radiation areas. This standard limits total personnel exposure to 1.25 rems per calendar quarter (29 CFR 1910.96).

For NPS personnel and Park visitors, the most appropriate radiation exposure standards are those developed by the Nuclear Regulatory Commission (NRC) for licensed facilities. The "Radiation Dose Limits for Individual Members of the Public" developed by NRC state the following (10 CFR 20 Subpart D):

Each licensee shall conduct operations so that-

- The total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem in one year.
- The dose in any unrestricted area from external sources does not exceed 0.002 rem in any one hour.

4.0 PRELIMINARY PATHWAY ANALYSIS

The emphasis of the PA is to evaluate human and environmental targets that may be threatened as a result of chemicals migrating from a site via groundwater, surface water, and air. Emphasis is also placed on evaluating targets that may come into direct contact with site-related chemicals in soil. The preliminary pathway analysis for this report was guided by the PA scoring process (EPA, 1991b). A PA score generated for the Orphan Mine is presented on the PA Scoresheets in Appendix B.

This section provides a discussion of the potential for chemical migration from the Orphan Mine site and the target receptors associated with each pathway. Although the discussion that follows in this section is largely qualitative, scoring criteria are included where applicable.

4.1 Groundwater Pathway

The potential for drinking water contamination from site-related chemicals migrating in groundwater is considered minimal to none. As discussed in Section 2.5, groundwater is present locally only in perched aquifers approximately 1000 feet below the rim surface.

Target populations considered under the groundwater pathway are humans supplied with drinking water from wells within 4 miles of the site. Drinking-water supplies for all park facilities within a four-mile radius of the site are transferred by pipeline from the Roaring Springs on the North Rim. A search conducted by the Arizona Department of Water Resources (1993) indicated no active wells are present within a 4-mile radius of the site, therefore, the groundwater pathway was not scored.

4.2 Surface Water Pathway

The potential for chemical migration from site sources to intermittent or perennial surface water bodies is considered low. Runoff from the upper mine area is away from the canyon, and is presumably lost to evaporation and ground infiltration. Runoff from the lower mine area, where spring water has been reported by the BLM to discharge from adits, is toward Horn Creek, an intermittent tributary to the Colorado River. The headwaters of Horn Creek

are approximately 1/2 mile downslope from the lower mine area (USGS, 1962). According to EPA Guidance (EPA, 1991b), the location of the headwaters of Horn Creek is considered the probable point of entry (PPE) of chemicals into surface water (Plate 4). However, concentrations of any chemicals potentially discharged from the lower mine area to the headwaters of Horn Creek would probably be negligible because 1) the percentage of uraninite in the Orphan Mine ore body is low (0.3 to 1.0 percent), 2) the spring water from the lower mine area would probably be diluted by collective runoff leading to the headwaters of Horn Creek, and 3) the distance between the spring water discharge from the lower mine area and the headwaters of Horn Creek is relatively far (0.5 miles). The flow rate of Horn Creek for most of its length is estimated as less than 10 cubic feet per second (cfs) because it is intermittent. However, the flow rate of Horn Creek may increase significantly where it empties into the Colorado River. The flow rate of the Colorado River is quite variable throughout GCNP, ranging between 7000 to 20,000 cfs (Arizona Department of Fish and Game, 1993).

The target distance limit for the surface water pathway is measured as 15 stream miles from the PPE (Plate 4). Targets include humans that might ingest drinking water or fish from downstream surface water bodies, and sensitive environments that occur along the 15 mile target distance limit. The segment of the Colorado River that flows through GCNP has no drinking water intakes, however it is a recreational fishery inhabited by rainbow trout, brown trout, sunchannel catfish, and striped bass (Arizona Department of Fish and Game, 1993). As reflected by the PA score, site-related chemicals that might reach the Colorado River would be rapidly diluted minimizing the potential for uptake by human food chain organisms.

Sensitive environments considered for the surface water pathway are indicated in PA Table 5 (Appendix B). A national park is considered a sensitive environment receiving the highest available assigned value for that scoring category. In addition, the federal and state endangered humpback chub and razorback sucker inhabit the segment of the Colorado River that flows through GCNP.

Negligible threat to downstream receptors is indicated by the overall surface water pathway score. The score is low because the chemical migration path from the site to Horn Creek is relatively far (1/2 mile), and because the dilution effects of the Colorado River are considered significant.

4.3 Soil Exposure Pathway

Targets considered under the soil exposure pathway are workers, residents, and people attending schools and daycare centers within 1 mile of the site, and terrestrial sensitive environments located on any area of suspected contamination.

GCNP is considered a terrestrial sensitive environment under the soil-exposure pathway, contributing to the target score. However, the overall potential threat associated with the soil exposure pathway as a result of chemicals from the Orphan Mine is considered low because there are no residents, schools, or regularly-present workers within one mile of the site.

4.4 Air Pathway

Radionuclides and other metals that may be present in surface soil on and near the site could migrate from the site via air. The radionuclide reconnaissance survey conducted during the site visit indicated beta plus gamma radiation above background levels is present at ground surface over portions of the upper mine area. A suspected release to air was conservatively assigned in the PA score.

Target receptors considered for the air pathway include resident, student, and worker populations within 4 miles of the site, and sensitive environments within 1/2 mile of the site. There are no resident, students, or workers that are regularly present within one mile of the site. Between 1 and 2 miles there are approximately 2000 residents and 300 students at South Rim Village. A daycare center with the capacity for 100 children is currently under construction at South Rim Village as well. Between 2 and 3 miles from the site an additional resident population of 200 was estimated (Plate 4). No other residents, students or workers were identified (NPS, 1993).

The fact that the site is within a national park accounted for the only significant contribution to the air target score. The overall score for the air pathway, however, is relatively low because regularly present human populations are beyond the distance that large quantities of chemicals would be expected to migrate in air.

5.0 CONCLUSIONS

The Orphan Mine is an inactive uranium mine located on the South Rim of the Grand Canyon. Types of chemicals known or suspected to be present include radionuclides and metals associated with scattered ore and waste rock. Diesel fuel was once stored onsite in at least one UST. Contents of an alleged second UST are not known.

Little threat to human or environmental target receptors is indicated as a result of evaluating the groundwater, surface water, soil exposure, and air pathways using PA scoring procedures. The most heavily weighted scoring factor was assigned on the basis of the presence of the site within a national park.

The overall site score using the standard PA score sheets was calculated as 13.47 (Appendix B). According to EPA guidance (EPA, 1991b), sites that score 28.50 or greater receive a further action recommendation, while sites that score less than 28.50 achieve the status "Site Evaluation Accomplished". The site score for the Orphan Mine indicates the site would not proceed further in the CERCLA site assessment process.

HLA concurs with the MSHA recommendations that no one should enter the mine tunnels unless the radiation levels are lowered. If the GCNP wishes to open the upper site area for public access. HLA concurs with the BLM recommendation for site reclamation. If the site is opened, reclamation should at least include mitigating physical site hazards. Based on the results of the PA. HLA is unable to assess if visitors and park employees direct contact with the site waste would cause adverse health effects. If the site is opened, either a baseline risk assessment should be performed to assess health effects resulting from direct exposure or the site should be reclaimed to background conditions. For either scenario,, the extent of mine waste at the upper and lower mine areas and the magnitude of radiation should be assessed. HLA presents a site investigation work plan and cost estimate details for completing the investigation in Appendix D. The investigation and UST closure would cost approximately $43,098. A baseline risk assessment would cost approximately $24,922, as detailed in Table

D-2 in Appendix D. Since the site is not fully characterized, HLA is unable to present cost projections for site reclamation.

HLA recommends that the UST identified at the site be closed in accordance with ADEQ regulations discussed in Section 3.3. Approximate closure costs would be $10,500 as detailed in Table D-1 in Appendix D.

6.0 REFERENCES

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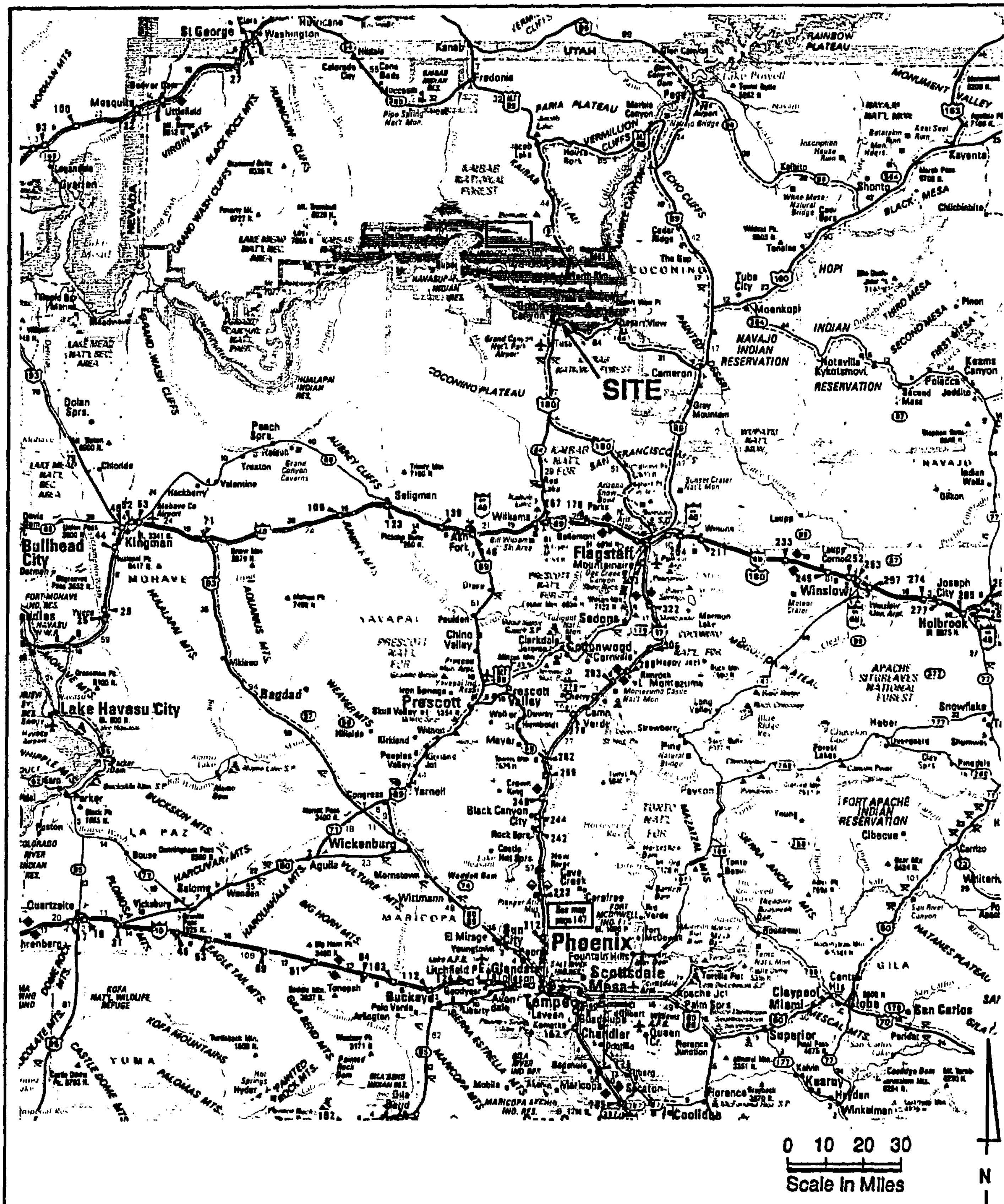
FIGURES



Reference: Rand McNally & Co., New York, NY, 1988.

Harding Lawson Associates Engineering and Environmental Services		**Site Vicinity Map** Orphan Mine Grand Canyon National Park, Arizona		PLATE **1**
DRAWN AM	JOB NUMBER 22040-002	APPROVED JR	DATE 12/92	REVISED DATE

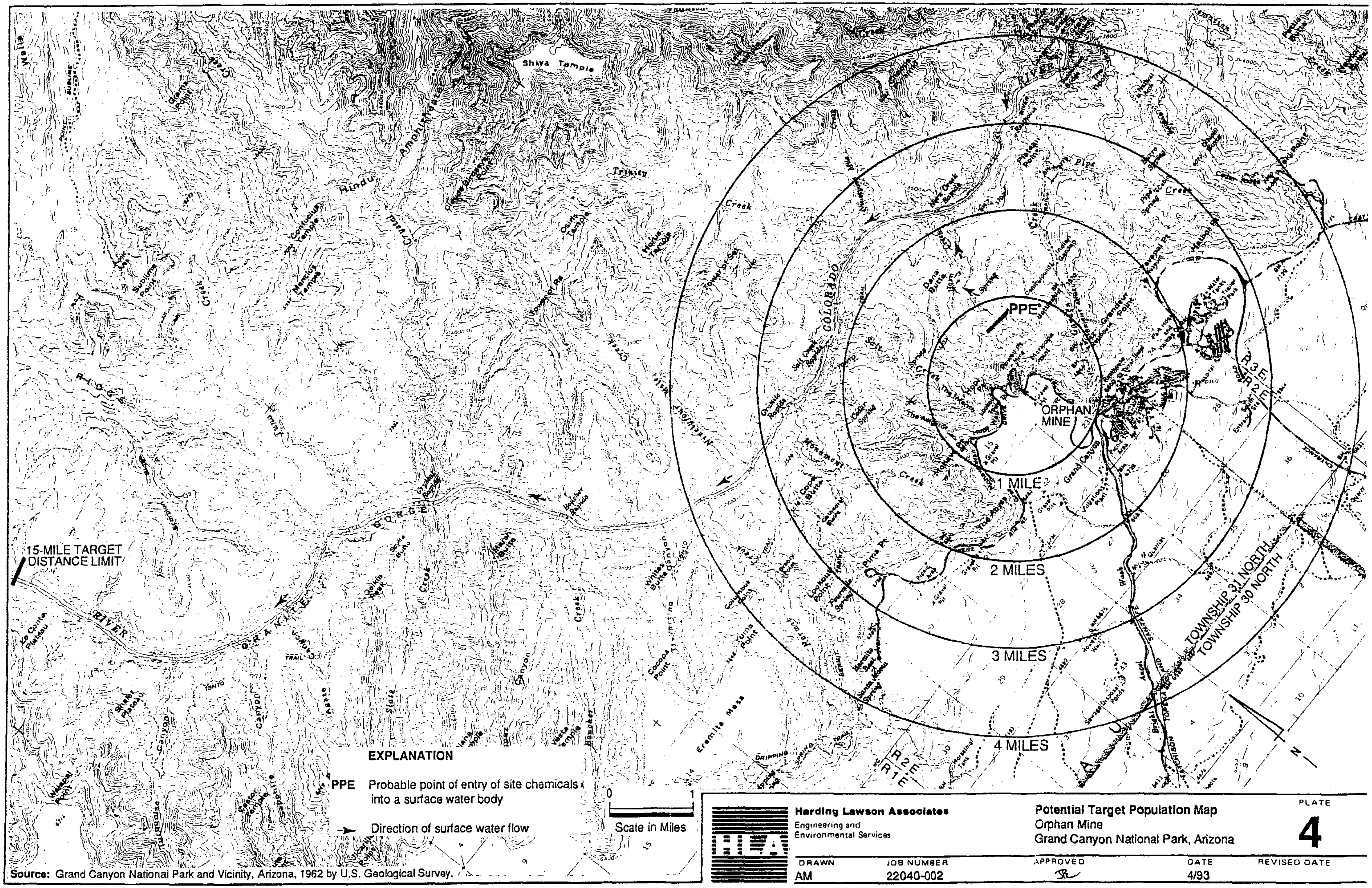
Reference: U.S.G.S., Grand Canyon National Park and Vicinity, Arizona, 1967.

Harding Lawson Associates
Engineering and
Environmental Services

Site Location Map
Orphan Mine
Grand Canyon National Park, Arizona

PLATE
2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
AM	22040-002	SR	12/92	



EXPLANATION

PPE Probable point of entry of site chemicals into a surface water body

→ Direction of surface water flow

0 1 Scale in Miles

Source: Grand Canyon National Park and Vicinity, Arizona, 1962 by U.S. Geological Survey.

Harding Lawson Associates
Engineering and Environmental Services

Potential Target Population Map
Orphan Mine
Grand Canyon National Park, Arizona

PLATE **4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
AM	22040-002	[signature]	4/93	

APPENDIX A

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT FORM

OMB Approval Number: 2050-0095
Approved for Use Through: 1/92

EPA Potential Hazardous Waste Site Preliminary Assessment Form

Identification

State: AZ | CERCLIS Number:

CERCLIS Discovery Date:

1. General Site Information

Name: NPS Orphan Mine

Street Address: 1½ miles northwest of South Rim Village

City: Grand Canyon National Park | State: AZ | Zip Code: | County: Coconino | Co. Code: | Cong. Dist:

Latitude: ___° ___' ___.___" Longitude: ___° ___' ___.___"

Approximate Area of Site: 3 Acres ___ Square Ft

Status of Site: ☐ Active ☐ Not Specified ☒ Inactive ☐ NA (GW plume, etc.)

2. Owner/Operator Information

Owner	Operator
National Park Service (NPS)	Inactive
Street Address: Denver Services Center, 13795 W. Alameda Parkway, P.O. Box 25287	Street Address: NA
City: Denver	City: NA
State: CO | Zip Code: 80225 | Telephone: (303) 969-2220	State: NA | Zip Code: NA | Telephone: NA ( )

Type of Ownership: ☐ Private ☒ Federal Agency (Name: NPS) ☐ State ☐ Indian ☐ County ☐ Municipal ☐ Not Specified ☐ Other

How Initially Identified: ☐ Citizen Complaint ☐ PA Petition ☐ State/Local Program ☐ RCRA/CERCLA Notification ☒ Federal Program ☐ Incidental ☐ Not Specified ☐ Other

3. Site Evaluator Information

Name of Evaluator: | Agency/Organization: Harding Lawson Associates | Date Prepared: April 1993

Street Address: 2400 ARCO Tower 707 Seventeenth Street | City: Denver | State: CO

Name of EPA or State Agency Contact: | Street Address:

City: | State: | Telephone: ( )

4. Site Disposition (for EPA use only)

Emergency Response/Removal Assessment Recommendation: ☐ Yes ☐ No Date: ___

CERCLIS Recommendation: ☐ Higher Priority SI ☐ Lower Priority SI ☐ NFRAP ☐ RCRA ☐ Other ___ Date: ___

Signature: Name (typed): Position:

EPA Potential Hazardous Waste Site
Preliminary Assessment Form - Page 2 of 4

CERCLIS Number:

5. General Site Characteristics

Predominant Land Uses Within 1 Mile of Site (check all that apply):
- ☐ Industrial
- ☐ Commercial
- ☐ Residential
- ☐ Farms/Fields
- ☐ Agriculture
- ☐ Mining
- ☐ DOD
- ☐ DOE
- ☐ DOI
- ☒ Other Federal Facility: National Park
- ☐ Other: _____

Site Setting:
- ☐ Urban
- ☐ Suburban
- ☒ Rural

Years of Operation:
- Beginning Year: 1906
- Ending Year: 1969
- ☐ Unknown

Type of Site Operations (check all that apply):
- ☐ Manufacturing (must check subcategory)
  - ☐ Lumber and Wood Products
  - ☐ Inorganic Chemicals
  - ☐ Plastic and/or Rubber Products
  - ☐ Paints, Varnishes
  - ☐ Industrial Organic Chemicals
  - ☐ Agricultural Chemicals (e.g., pesticides, fertilizers)
  - ☐ Miscellaneous Chemical Products (e.g., adhesives, explosives, etc.)
  - ☐ Primary Metals
  - ☐ Metal Coating, Plating, Engraving
  - ☐ Metal Forging, Stamping
  - ☐ Fabricated Structural Metal Products
  - ☐ Electronic Equipment
  - ☐ Other Manufacturing
- ☒ Mining
  - ☒ Metals
  - ☐ Coal
  - ☐ Oil and Gas
  - ☐ Non-metallic Minerals
- ☐ Retail
- ☐ Recycling
- ☐ Junk/Salvage Yard
- ☐ Municipal Landfill
- ☐ Other Landfill: _____
- ☐ DOD
- ☐ DOE
- ☐ DOI
- ☐ Other Federal Facility: _____
- ☐ RCRA
  - ☐ Treatment, Storage, or Disposal
  - ☐ Large Quantity Generator
  - ☐ Small Quantity Generator
  - ☐ Subtitle D
    - ☐ Municipal
    - ☐ Industrial
  - ☐ "Converter"
  - ☐ "Transient Filer"
  - ☐ "Non- or Less Filer"
- ☐ Not Specified
- ☐ Other: _____

Waste Generated:
- ☒ Onsite
- ☐ Offsite
- ☐ Onsite and Offsite

Waste Deposition Authorized By:
- ☐ Present Owner
- ☒ Former Owner
- ☐ Present & Former Owner
- ☐ Unauthorized
- ☐ Unknown

Waste Accessible to the Public:
- ☒ Yes
- ☐ No

Distance to Nearest Dwelling, School, or Workplace: 2-3 miles

6. Waste Characteristics Information

Source Type: (check all that apply)	Source Waste Quantity: (include units)	Tier*:
☐ Landfill		
☐ Surface Impoundment		
☐ Drums		
☒ Tanks and Non-Drum Containers		V
☐ Chemical Waste Pile		
☐ Scrap Metal or Junk Pile		
☐ Tailings Pile		
☐ Trash Pile (open dump)		
☐ Land Treatment		
☐ Contaminated Ground Water Plume (unidentified source)		
☐ Contaminated Surface Water/Sediment (unidentified source)		
☒ Contaminated Soil		A
☐ Other: _____		
☐ No Sources		

* C = Containment, W = Wastestream, V = Volume, A = Area

General Types of Waste (check all that apply)
- ☒ Metals
- ☐ Organics
- ☐ Inorganics
- ☐ Solvents
- ☐ Paints/Pigments
- ☐ Laboratory/Hospital Wastes
- ☒ Radioactive Wastes
- ☐ Construction/Demolition Wastes
- ☐ Pesticides/Herbicides
- ☐ Acids/Bases
- ☐ Oily Wastes
- ☐ Municipal Wastes
- ☒ Mining Wastes
- ☐ Explosives
- ☐ Other: _____

Physical State of Waste as Deposited (check all that apply):
- ☒ Solid
- ☐ Sludge
- ☐ Powder
- ☐ Liquid
- ☐ Gas

EPA Potential Hazardous Waste Site
Preliminary Assessment Form - Page 3 of 4

CERCLIS Number:

7. Ground Water Pathway

Is Ground Water Used for Drinking Water Within 4 Miles:
☐ Yes
☒ No

Is There a Suspected Release to Ground Water:
☐ Yes
☒ No

List Secondary Target Populations Served by Ground Water Withdrawn From:

0 - ¼ Mile _____
> ¼ - ½ Mile _____
> ½ - 1 Mile _____
> 1 - 2 Miles _____
> 2 - 3 Miles _____
> 3 - 4 Miles _____
Total Within 4 Miles 0

Type of Drinking Water Wells Within 4 Miles (check all that apply):
☐ Municipal
☐ Private
☒ None

Have Primary Target Drinking Water Wells Been Identified:
☐ Yes
☒ No

If Yes, Enter Primary Target Population:
_____ People

Depth to Shallowest Aquifer:
1000 Feet

Karst Terrain/Aquifer Present:
☐ Yes
☒ No

Nearest Designated Wellhead Protection Area:
☐ Underlies Site
☐ > 0 - 4 Miles
☒ None Within 4 Miles

8. Surface Water Pathway

Type of Surface Water Draining Site and 15 Miles Downstream (check all that apply):
☒ Stream ☒ River ☐ Pond ☐ Lake
☐ Bay ☐ Ocean ☐ Other _____

Shortest Overland Distance From Any Source to Surface Water:
_____ Feet
1/2 Miles to head of Horn Creek

Is There a Suspected Release to Surface Water:
☐ Yes
☒ No

Site is Located in:
☐ Annual - 10 yr Floodplain
☐ > 10 yr - 100 yr Floodplain
☐ > 100 yr - 500 yr Floodplain
☒ > 500 yr Floodplain

Drinking Water Intakes Located Along the Surface Water Migration Path:
☐ Yes
☒ No

Have Primary Target Drinking Water Intakes Been Identified:
☐ Yes
☒ No

If Yes, Enter Population Served by Primary Target Intakes:
_____ People

List All Secondary Target Drinking Water Intakes:

Name	Water Body	Flow (cfs)	Population Served
NA			

Total within 15 Miles None

Fisheries Located Along the Surface Water Migration Path:
☐ Yes
☒ No

Have Primary Target Fisheries Been Identified:
☐ Yes
☒ No

List All Secondary Target Fisheries:

Water Body/Fishery Name	Flow (cfs)
Colorado River	7,000 - 20,000

EPA Potential Hazardous Waste Site
Preliminary Assessment Form - Page 4 of 4

CERCLIS Number:

8. Surface Water Pathway (continued)

Wetlands Located Along the Surface Water Migration Path:
- ☐ Yes
- ☒ No

Have Primary Target Wetlands Been Identified:
- ☐ Yes
- ☒ No

List Secondary Target Wetlands:

Water Body	Flow (cfs)	Frontage Miles
None		

Other Sensitive Environments Located Along the Surface Water Migration Path:
- ☒ Yes
- ☐ No

Have Primary Target Sensitive Environments Been Identified:
- ☐ Yes
- ☒ No

List Secondary Target Sensitive Environments:

Water Body	Flow (cfs)	Sensitive Environment Type
Horn Creek	<10	National Park

9. Soil Exposure Pathway

Are People Occupying Residences or Attending School or Daycare on or Within 200 Feet of Areas of Known or Suspected Contamination:
- ☐ Yes
- ☒ No

If Yes, Enter Total Resident Population:
NA People

Number of Workers Onsite:
- ☒ None
- ☐ 1 - 100
- ☐ 101 - 1,000
- ☐ > 1,000

Have Terrestrial Sensitive Environments Been Identified on or Within 200 Feet of Areas of Known or Suspected Contamination:
- ☐ Yes
- ☒ No

If Yes, List Each Terrestrial Sensitive Environment:
NA

10. Air Pathway

Is There a Suspected Release to Air:
- ☒ Yes
- ☐ No

Enter Total Population on or Within:

Onsite	0
0 - ¼ Mile	0
> ¼ - ½ Mile	0
> ½ - 1 Mile	0
> 1 - 2 Miles	3400
> 2 - 3 Miles	300
> 3 - 4 Miles	0
Total Within 4 Miles	3700

Wetlands Located Within 4 Miles of the Site:
- ☐ Yes
- ☒ No

Other Sensitive Environments Located Within 4 Miles of the Site:
- ☒ Yes
- ☐ No

List All Sensitive Environments Within ½ Mile of the Site:

Distance	Sensitive Environment Type/Wetlands Area (acres)
Onsite	National Park
0 - ¼ Mile	National Park
> ¼ - ½ Mile	National Park

APPENDIX B

PRELIMINARY ASSESSMENT SCORESHEETS

APPENDIX A

OMB Approval Number: 2050-0095
Approved for Use Through: 1/92

PA Scoresheets

Site Name: NPS Orphan Mine

CERCLIS ID No.: _____

Street Address: 1½ miles NW of South Rim Village

City/State/Zip: Grand Canyon National Park, AZ

Investigator: _____

Agency/Organization: National Park Service Denver Services Center

Street Address: 12795 W. Alameda Parkway

City/State/Zip: Denver, CO 80225

Date: 4/1993

GENERAL INFORMATION

Site Description and Operational History:

- 3 acre uranium mine including upper mine area and lower mine area
- inactive
- date of operation: 1906 - 1969

See Text for additional information

Probable Substances of Concern:
(Previous investigations, analytical data)

Radionuclides
Heavy metals
Diesel fuel

Site Sketch:
(Show all pertinent features, indicate sources and closest targets, indicate north)

SOURCE EVALUATION

Source No.: 1	Source Name: Potentially Contaminated Soil	Source Waste Quantity (WQ) Calculations:
Source Description: Conservatively assume the entire site area is contaminated as described below: Upper Mine Area Inside fence = 3 acres Outside fence = 1 acre Lower Mine Area = 2 acres 6 acres		Tier: Area 6 acres ÷ 0.78 = 7.69

Source No.: 2	Source Name: Underground Storage Tank	Source Waste Quantity (WQ) Calculations:
Source Description: Dimensions of UST are 5 ft wide × 13 ft long × unknown height. Assume tank volume = 5,000 gal		Tier: Volume 5,000 gal ÷ 500 = 10

Source No.: 3	Source Name: Possible Second UST	Source Waste Quantity (WQ) Calculations:
Source Description: Assume tank volume = 5,000 gal		Tier: Volume 5,000 gal ÷ 500 = 10

7.69 + 10 + 10 = 27.69 = WC Total
WC Score = 18
(see PA Table 16)

Site WC: 18

PA TABLE 1: WASTE CHARACTERISTICS (WC) SCORES

PA Table 1a: WC Scores for Single Source Sites and Formulas for Multiple Source Sites

	SOURCE TYPE	SINGLE SOURCE SITES (assigned WC scores)			MULTIPLE SOURCE SITES
		WC = 18	*WC = 32*	*WC = 100*	Formula for Assigning Source WC Values
TOXICITY/MOBILITY	N/A	≤100 lb	>100 to 10,000 lb	>10,000 lb	*lb ÷ 1*
PERSISTENCE	N/A	≤500,000 lb	>500,000 to 50 million lb	>50 million lb	*lb ÷ 5,000*
VOLUME	Landfill	≤6.75 million ft³ ≤250,000 yd³	>6.75 million to 675 million ft³ >250,000 to 25 million yd³	>675 million ft³ >25 million yd³	*ft³ ÷ 67,500* *yd³ ÷ 2,500*
	Surface impoundment	≤6,750 ft³ ≤250 yd³	>6,750 to 675,000 ft³ >250 to 25,000 yd³	>675,000 ft³ >25,000 yd³	*ft³ ÷ 67.5* *yd³ ÷ 2.5*
	Drums	≤1,000 drums	>1,000 to 100,000 drums	>100,000 drums	*drums ÷ 10*
	Tanks and non-drum containers	≤50,000 gallons	>50,000 to 5 million gallons	>5 million gallons	*gallons ÷ 500*
	Contaminated soil	≤6.75 million ft³ ≤250,000 yd³	>6.75 million to 675 million ft³ >250,000 to 25 million yd³	>675 million ft³ >25 million yd³	*ft³ ÷ 67,500* *yd³ ÷ 2,500*
	Pile	≤6,750 ft³ ≤250 yd³	>6,750 to 675,000 ft³ >250 to 25,000 yd³	>675,000 ft³ >25,000 yd³	*ft³ ÷ 67.5* *yd³ ÷ 2.5*
	Other	≤6,750 ft³ ≤250 yd³	>6,750 to 675,000 ft³ >250 to 25,000 yd³	>675,000 ft³ >25,000 yd³	*ft³ ÷ 67.5* *yd³ ÷ 2.5*
AREA	Landfill	≤340,000 ft² ≤7.8 acres	>340,000 to 34 million ft² >7.8 to 780 acres	>34 million ft² >780 acres	*ft² ÷ 3,400* *acres ÷ 0.078*
	Surface impoundment	≤1,300 ft² ≤0.029 acres	>1,300 to 130,000 ft² >0.029 to 2.9 acres	>130,000 ft² >2.9 acres	*ft² ÷ 13* *acres ÷ 0.00029*
	Contaminated soil	≤3.4 million ft² ≤78 acres	>3.4 million to 340 million ft² >78 to 7,800 acres	>340 million ft² >7,800 acres	*ft² ÷ 34,000* *acres ÷ 0.78*
	Pile*	≤1,300 ft² ≤0.029 acres	>1,300 to 130,000 ft² >0.029 to 2.9 acres	>130,000 ft² >2.9 acres	*ft² ÷ 13* *acres ÷ 0.00029*
	Land treatment	≤27,000 ft² ≤0.62 acres	>27,000 to 2.7 million ft² >0.62 to 62 acres	>2.7 million ft² >62 acres	*ft² ÷ 270* *acres ÷ 0.0062*

* ton = 2,000 lb = 1 yd³ = 4 drums = 200 gallons

* Use area of land surface under pile, not surface area of pile.

PA Table 1b: WC Scores for Multiple Source Sites

WC Total	WC Score
>0 to 100	18
>100 to 10,000	32
>10,000	100

GROUND WATER PATHWAY
GROUND WATER USE DESCRIPTION

Describe Ground Water Use Within 4-miles of the Site:
(Describe stratigraphy, information on aquifers, municipal and/or private wells)

None

Calculations for Drinking Water Populations Served by Ground Water:

NA

GROUND WATER PATHWAY CRITERIA LIST

SUSPECTED RELEASE				PRIMARY TARGETS			
Yes	No	Unk		Yes	No	Unk	
X			Are sources poorly contained?		X		Is any drinking water well nearby?
	X		Is the source a type likely to contribute to ground water contamination (e.g., wet lagoon)?		X		Has any nearby drinking water well been closed?
	X		Is waste quantity particularly large?		X		Has any nearby drinking water user reported foul-tasting or foul-smelling water?
	X		Is precipitation heavy?		X		Does any nearby well have a large drawdown or high production rate?
	X		Is the infiltration rate high?		X		Is any drinking water well located between the site and other wells that are suspected to be exposed to a hazardous substance?
	X		Is the site located in an area of karst terrain?		X		Does analytical or circumstantial evidence suggest contamination at a drinking water well?
	X		Is the subsurface highly permeable or conductive?		X		Does any drinking water well warrant sampling?
	X		Is drinking water drawn from a shallow aquifer?				Other criteria? _____
	X		Are suspected contaminants highly mobile in ground water?		X		PRIMARY TARGET(S) IDENTIFIED?
	X		Does analytical or circumstantial evidence suggest ground water contamination?				
			Other criteria? _____				
	X		SUSPECTED RELEASE?				

Summarize the rationale for Suspected Release (attach an additional page if necessary):

No suspected release to groundwater.

Summarize the rationale for Primary Targets (attach an additional page if necessary):

No primary targets.

Ground water pathway was not scored because there are no active wells within 4 miles of the site.

GROUND WATER PATHWAY SCORESHEET

Pathway Characteristics	
Do you suspect a release (see Ground Water Pathway Criteria List, page 71?	Yes ___ No X
Is the site located in karst terrain?	Yes ___ No X
Depth to aquifer:	1000 ft
Distance to the nearest drinking water well:	>4 miles

	A Suspected Release	B No Suspected Release	Reference
LIKELIHOOD OF RELEASE			
1. SUSPECTED RELEASE: If you suspect a release to ground water (see page 71), assign a score of 550. Use only column A for this pathway.			
2. NO SUSPECTED RELEASE: If you do not suspect a release to ground water, and the site is in karst terrain or the depth to aquifer is 70 feet or less, assign a score of 500; otherwise, assign a score of 340. Use only column B for this pathway.			
LR =			
TARGETS			
3. PRIMARY TARGET POPULATION: Determine the number of people served by drinking water wells that you suspect have been exposed to a hazardous substance from the site (see Ground Water Pathway Criteria List, page 71). ____ people x 10 =			
4. SECONDARY TARGET POPULATION: Determine the number of people served by drinking water wells that you do NOT suspect have been exposed to a hazardous substance from the site, and assign the total population score from PA Table 2. Are any wells part of a blended system? Yes ___ No ___ If yes, attach a page to show apportionment calculations.			
5. NEAREST WELL: If you have identified a primary target population for ground water, assign a score of 50; otherwise, assign the Nearest Well score from PA Table 2. If no drinking water wells exist within 4 miles, assign a score of zero.			
6. WELLHEAD PROTECTION AREA (WHPA): If any source lies within or above a WHPA, or if you have identified any primary target well within a WHPA, assign a score of 20; assign 5 if neither condition holds but a WHPA is present within 4 miles; otherwise assign zero.			
7. RESOURCES			
T =			
WASTE CHARACTERISTICS			
8. A. If you have identified any primary target for ground water, assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor. B. If you have NOT identified any primary target for ground water, assign the waste characteristics score calculated on page 4.			
WC =			

GROUND WATER PATHWAY SCORE: $\frac{LR \times T \times WC}{82,500}$ (limited to a maximum of 100) NA

PA TABLE 2: VALUES FOR SECONDARY GROUND WATER TARGET POPULATIONS

(NA)

PA Table 2a: Non Karst Aquifers

Distance from Site	Population	Nearest Well (choose highest)	Population Served by Wells Within Distance Category: 1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	Greater than 100,000	Population Value
0 to ¼ mile	_____	20	1	2	6	16	52	163	521	1,633	5,214	16,325	_____
> ¼ to ½ mile	_____	18	1	1	3	10	32	101	323	1,012	3,233	10,121	_____
> ½ to 1 mile	_____	9	1	1	2	6	17	52	167	522	1,668	5,224	_____
> 1 to 2 miles	_____	5	1	1	1	3	9	29	94	294	939	2,938	_____
> 2 to 3 miles	_____	3	1	1	1	2	7	21	68	212	678	2,122	_____
> 3 to 4 miles	_____	2	1	1	1	1	4	13	42	131	417	1,306	_____
Nearest Well =												Score =	

PA Table 2b: Karst Aquifers

Distance from Site	Population	Nearest Well (use 20 for karst)	Population Served by Wells Within Distance Category: 1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	Greater than 100,000	Population Value
0 to ¼ mile	_____	20	1	2	6	16	52	163	521	1,633	5,214	16,325	_____
> ¼ to ½ mile	_____	20	1	1	3	10	32	101	323	1,012	3,233	10,121	_____
> ½ to 1 mile	_____	20	1	1	3	8	26	82	261	816	2,607	8,162	_____
> 1 to 2 miles	_____	20	1	1	3	8	26	82	261	816	2,607	8,162	_____
> 2 to 3 miles	_____	20	1	1	3	8	26	82	261	816	2,607	8,162	_____
> 3 to 4 miles	_____	20	1	1	3	8	26	82	261	816	2,607	8,162	_____
Nearest Well =												Score =	

SURFACE WATER PATHWAY
MIGRATION ROUTE SKETCH

Suface Water Migration Route Sketch:
(include runoff route, probable point of entry, 15-mile target distance limit, intakes, fisheries, and sensitive environments)

SURFACE WATER PATHWAY CRITERIA LIST

SUSPECTED RELEASE

Yes	No	Unk	
☐	☒	☐	Is surface water nearby?
☐	☒	☐	Is waste quantity particularly large?
☒	☐	☐	Is the drainage area large?
☐	☒	☐	Is rainfall heavy?
☒	☐	☐	Is the infiltration rate low?
☒	☐	☐	Are sources poorly contained or prone to runoff or flooding?
☐	☒	☐	Is a runoff route well defined (e.g., ditch or channel leading to surface water)?
☐	☒	☐	Is vegetation stressed along the probable runoff route?
☐	☒	☐	Are sediments or water unnaturally discolored?
☐	☒	☐	Is wildlife unnaturally absent?
☐	☒	☐	Has deposition of waste into surface water been observed?
☒	☐	☐	Is ground water discharge to surface water likely?
☐	☒	☐	Does analytical or circumstantial evidence suggest surface water contamination?
☐	☐		Other criteria? _____
☐	☐		**SUSPECTED RELEASE?**

PRIMARY TARGETS

Yes	No	Unk	
☒	☐	☐	Is any target nearby? If yes:
			☐ Drinking water intake ☐ Fishery ☒ Sensitive environment
☐	☒	☐	Has any intake, fishery, or recreational area been closed?
☐	☒	☐	Does analytical or circumstantial evidence suggest surface water contamination at or downstream of a target?
☐	☒	☐	Does any target warrant sampling? If yes:
			☐ Drinking water intake ☐ Fishery ☐ Sensitive environment
☐	☐		Other criteria? _____
☐	☒		**PRIMARY INTAKE(S) IDENTIFIED?**
☐	☒		**PRIMARY FISHERY(IES) IDENTIFIED?**
☐	☒		**PRIMARY SENSITIVE ENVIRONMENT(S) IDENTIFIED?**

Summarize the rationale for Suspected Release (attach an additional page if necessary):

No suspected release to surface water.

Summarize the rationale for Primary Targets (attach an additional page if necessary):

No suspected release to surface water; therefore no primary targets. The site is within a national park which is considered a sensitive environment for scoring purposes.

Surface water pathway drinking water threat was not scored because no drinking water intakes exist within 15 downstream miles of the site.

SURFACE WATER PATHWAY
LIKELIHOOD OF RELEASE AND DRINKING WATER THREAT SCORESHEET

Pathway Characteristics

Do you suspect a release (see Surface Water Pathway Criteria List, page 111)? Yes ___ No X
Distance to surface water: 2640 ft
Flood frequency: >500 yrs
What is the downstream distance to the nearest drinking water intake? N/A miles
Nearest fishery? 2 miles Nearest sensitive environment? 1/2 miles

	A	B	
	Suspected Release	No Suspected Release	Reference
LIKELIHOOD OF RELEASE			
1. SUSPECTED RELEASE: If you suspect a release to surface water (see page 11), assign a score of 550. Use only column A for this pathway.	550		
2. NO SUSPECTED RELEASE: If you do not suspect a release to surface water use the table below to assign a score based on distance to surface water and flood frequency. Use only column B for this pathway.			
Distance to surface water ≤ 2,500 feet		500	
Distance to surface water > 2,500 feet, and			
Site in annual or 10-year floodplain		500	
Site in 100-year floodplain		400	
Site in 500-year floodplain		300	
Site outside 500-year floodplain		100	
LR =			
DRINKING WATER THREAT TARGETS			
3. Record the water body type, flow (if applicable), and number of people served by each drinking water intake within the target distance limit. If there is no drinking water intake within the target distance limit, factors 4, 5, and 6 each receive zero scores.			
Intake Name / Water Body Type / Flow / People Served			
___ / ___ / ___ cfs / ___			
___ / ___ / ___ cfs / ___			
___ / ___ / ___ cfs / ___			
4. PRIMARY TARGET POPULATION: If you suspect any drinking water intake listed above has been exposed to a hazardous substance from the site (see Surface Water Pathway Criteria List, page 111), list the intake name(s) and calculate the factor score based on the total population served.			
___, ___			
___ people x 10 =			
5. SECONDARY TARGET POPULATION: Determine the number of people served by drinking water intakes that you do NOT suspect have been exposed to a hazardous substance from the site, and assign the total population score from PA Table 3.			
Are any intakes part of a blended system? Yes ___ No ___			
If yes, attach a page to show apportionment calculations.			
6. NEAREST INTAKE: If you have identified a primary target population for the drinking water threat (factor 4), assign a score of 50; otherwise, assign the Nearest Intake score from PA Table 3. If no drinking water intake exists within the target distance limit, assign a score of zero.			
7. RESOURCES			
T =			

PA TABLE 3: VALUES FOR SECONDARY SURFACE WATER TARGET POPULATIONS

(NA)

Surface Water Body Flow (see PA Table 4)	Population	Nearest Intake (choose highest)	Population Served by Intakes Within Flow Category: 1 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	Greater than 1,000,000	Population Value
< 10 cfs	_____	20	2	5	16	52	163	521	1,633	5,214	16,325	52,136	163,246	_____
10 to 100 cfs	_____	2	1	1	2	5	16	52	163	521	1,633	5,214	16,325	_____
> 100 to 1,000 cfs	_____	1	0	0	1	1	2	5	16	52	163	521	1,633	_____
> 1,000 to 10,000 cfs	_____	0	0	0	0	0	1	1	2	5	16	52	163	_____
> 10,000 cfs or Great Lakes	_____	0	0	0	0	0	0	0	1	1	2	5	16	_____
3 mile Mixing Zone	_____	10	1	3	8	26	82	261	816	2,607	8,162	26,068	81,663	_____
Nearest Intake =													Score =	

PA TABLE 4: SURFACE WATER TYPE / FLOW CHARACTERISTICS WITH DILUTION WEIGHTS FOR SECONDARY SURFACE WATER SENSITIVE ENVIRONMENTS

Type of Surface Water Body: Water Body Type	OR	Flow	Dilution Weight
minimal stream		< 10 cfs	1
small to moderate stream		10 to 100 cfs	0.1
moderate to large stream		> 100 to 1,000 cfs	N/A
large stream to river		> 1,000 to 10,000 cfs	N/A
large river		> 10,000 cfs	N/A
3 mile mixing zone of quiet flowing streams or rivers		10 cfs or greater	N/A
coastal tidal water (harbors, sounds, bays, etc.), ocean, or Great Lakes		N/A	N/A

SURFACE WATER PATHWAY (continued)
HUMAN FOOD CHAIN THREAT SCORESHEET

LIKELIHOOD OF RELEASE		A Observed Release	B No Observed Release	Reference
Enter Surface Water Likelihood of Release score from page 12.	LR =		100	

HUMAN FOOD CHAIN THREAT TARGETS

8. Record the water body type and flow (if applicable) for each fishery within the target distance limit. If there is no fishery within the target distance limit, assign a Targets score of 0 at the bottom of the page.

Fishery Name	Water Body Type	Flow	
Colorado River	River	7000 - 29,000	cfs
			cfs
			cfs
			cfs
			cfs

9. PRIMARY FISHERIES: If you suspect any fishery listed above has been exposed to a hazardous substance from the site (see Surface Water Criteria List, page 111), assign a score of 300 and do not evaluate Factor 10. List the primary fisheries:

10. SECONDARY FISHERIES

A. If you suspect a release to surface water and have identified a secondary fishery but no primary fishery, assign a score of 210.

B. If you do not suspect a release, assign a Secondary Fisheries score from the table below using the lowest flow at any fishery within the target distance limit.

Lowest Flow	Secondary Fisheries Score
< 10 cfs	210
10 to 100 cfs	30
> 100 cfs, coastal tidal waters, oceans, or Great Lakes	12

			12	
T =			12	

SURFACE WATER PATHWAY (continued)
ENVIRONMENTAL THREAT SCORESHEET

LIKELIHOOD OF RELEASE		A Surface Release	B No Surface Release	Reference
Enter Surface Water Likelihood of Release score from page 12.	LR =		100	

ENVIRONMENTAL THREAT TARGETS

11. Record the water body type and flow (if applicable) for each surface water sensitive environment within the target distance limit (see PA Tables 4 and 5). If there is no sensitive environment within the target distance limit, assign a Targets score of 0 at the bottom of the page.

Environment Name	Water Body Type	Flow
National Park - Horn Creek	Intermittent Stream	< 10 cfs
National Park - Colorado River	River	> 7,000 - 20,000 cfs
		cfs
		cfs
		cfs

12. PRIMARY SENSITIVE ENVIRONMENTS: If you suspect any sensitive environment listed above has been exposed to a hazardous substance from the site (see Surface Water Criteria List, page 11), assign a score of 300 and do not evaluate factor 13. List the primary sensitive environments:

13. SECONDARY SENSITIVE ENVIRONMENTS: If sensitive environments are present, but none is a primary sensitive environment, evaluate Secondary Sensitive Environments based on flow.

A. For secondary sensitive environments on surface water bodies with flows of 100 cfs or less, assign scores as follows, and do not evaluate part B of this factor:

Flow		Dilution Weight (PA Table 4)		Environment Type and Value (PA Tables 5 and 6)		Total
< 10		1	x	National Park	100 =	100
			x		=	
			x		=	
			x		=	
			x		=	
					Sum =	100

B. If all secondary sensitive environments are located on surface water bodies with flows > 100 cfs, assign a score of 10. —

	T =		100

PA TABLE 5: SURFACE WATER AND AIR PATHWAY SENSITIVE ENVIRONMENTS VALUES

Sensitive Environment	*Assigned Value*
Critical habitat for Federally designated endangered or threatened species	100
Marine Sanctuary	
National Park	
Designated Federal Wilderness Area	
Ecologically important areas identified under the Coastal Zone Wilderness Act	
Sensitive Areas identified under the National Estuary Program or Near Coastal Water Program of the Clean Water Act	
Critical Areas identified under the Clean Lakes Program of the Clean Water Act (subareas on lakes or entire small lakes)	
National Monument (air pathway only)	
National Seashore Recreation Area	
National Lakeshore Recreation Area	
Habitat known to be used by Federally designated or proposed endangered or threatened species	75
National Preserve	
National or State Wildlife Refuge	
Unit of Coastal Barrier Resources System	
Federal land designated for the protection of natural ecosystems	
Administratively Proposed Federal Wilderness Area	
Spawning areas critical for the maintenance of fish/shellfish species within a river system, bay, or estuary	
Migratory pathways and feeding areas critical for the maintenance of anadromous fish species in a river system	
Terrestrial areas utilized for breeding by large or dense aggregations of vertebrate animals (air pathway) or semi-aquatic foragers (surface water pathway)	
National river reach designated as Recreational	
Habitat known to be used by State designated endangered or threatened species	50
Habitat known to be used by a species under review as to its Federal endangered or threatened status	
Coastal Barrier (partially developed)	
Federally designated Scenic or Wild River	
State land designated for wildlife or game management	25
State designated Scenic or Wild River	
State designated Natural Area	
Particular areas, relatively small in size, important to maintenance of unique biotic communities	
State designated areas for protection/maintenance of aquatic life under the Clean Water Act	5
Wetlands	See PA Table 6 (Surface Water Pathway) or PA Table 9 (Air Pathway)

PA TABLE 6: SURFACE WATER PATHWAY WETLANDS FRONTAGE VALUES

Total Length of Wetlands	*Assigned Value*
Less than 0.1 mile	0
0.1 to 1 mile	25
Greater than 1 to 2 miles	50
Greater than 2 to 3 miles	75
Greater than 3 to 4 miles	100
Greater than 4 to 8 miles	150
Greater than 8 to 12 miles	250
Greater than 12 to 16 miles	350
Greater than 16 to 20 miles	450
Greater than 20 miles	500

SURFACE WATER PATHWAY (concluded)
WASTE CHARACTERISTICS, THREAT, AND PATHWAY SCORE SUMMARY

WASTE CHARACTERISTICS	A Suspected Release	B No Suspected Release
14 A. If you have identified any primary target for surface water (pages 12, 14, or 15), assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor.		
B. If you have NOT identified any primary target for surface water, assign the waste characteristics score calculated on page 4.		18
WC =		18

SURFACE WATER PATHWAY THREAT SCORES

Threat	Likelihood of Release (LR) Score (from page 12)	Targets (T) Score (pages 12, 14, 15)	Pathway Waste Characteristics (WC) Score (determined above)	Threat Score LR x T x WC / 82,500
Drinking Water	—	—	—	—
Human Food Chain	100	12	18	0.26
Environmental	100	100	18	2.18

SURFACE WATER PATHWAY SCORE
(Drinking Water Threat + Human Food Chain Threat + Environmental Threat)

2.44

SOIL EXPOSURE PATHWAY CRITERIA LIST

SUSPECTED CONTAMINATION	*RESIDENT POPULATION*			
	Yes	No	Unk	
Surficial contamination can generally be assumed.	☐	☒	☐	Is any residence, school, or daycare facility on or within 200 feet of an area of suspected contamination?
	☐	☒	☐	Is any residence, school, or daycare facility located on adjacent land previously owned or leased by the site owner/operator?
	☐	☒	☐	Is there a migration route that might spread hazardous substances near residences, schools, or daycare facilities?
	☐	☒	☐	Have onsite or adjacent residents or students reported adverse health effects, exclusive of apparent drinking water or air contamination problems?
	☐	☒	☐	Does any neighboring property warrant sampling?
	☐	☐		Other criteria? _____
	☐	☐		**RESIDENT POPULATION IDENTIFIED?**

Summarize the rationale for Resident Population (attach an additional page if necessary):

No resident population identified.

SOIL EXPOSURE PATHWAY SCORESHEET

Pathway Characteristics

Do any people live on or within 200 ft of areas of suspected contamination? Yes ___ No X

Do any people attend school or daycare on or within 200 ft of areas of suspected contamination? Yes ___ No X

Is the facility active? Yes ___ No X If yes, estimate the number of workers: NA

LIKELIHOOD OF EXPOSURE	Assigned Value	Reference
1. SUSPECTED CONTAMINATION: Surficial contamination can generally be assumed, and a score of 550 assigned. Assign zero only if the absence of surficial contamination can be conclusively demonstrated. LE =	550	
RESIDENT POPULATION THREAT TARGETS		
2. RESIDENT POPULATION: Determine the number of people occupying residences or attending school or daycare on or within 200 feet of areas of suspected contamination (see Soil Exposure Pathway Criteria List, page 181). 0 people x 10 =	0	
3. RESIDENT INDIVIDUAL: If you have identified a resident population (factor 2), assign a score of 50; otherwise, assign a score of 0.	0	
4. WORKERS: Use the following table to assign a score based on the total number of workers at the facility and nearby facilities with suspected contamination:	0	
5. TERRESTRIAL SENSITIVE ENVIRONMENTS: Use PA Table 7 to assign a value for each terrestrial sensitive environment on an area of suspected contamination:		
6. RESOURCES	5	
T =	105	
WASTE CHARACTERISTICS		
7. Assign the waste characteristics score calculated on page 4. WC =	18	
RESIDENT POPULATION THREAT SCORE: LE X T X WC / 82,500.	12.60	
NEARBY POPULATION THREAT SCORE:	1	
SOIL EXPOSURE PATHWAY SCORE: Resident Population Threat + Nearby Population Threat	13.60	

Number of Workers	Score
0	0
1 to 100	5
101 to 1,000	10
>1,000	15

Terrestrial Sensitive Environment Type	Value
National Park	100
Sum =	100

PA TABLE 7: SOIL EXPOSURE PATHWAY
TERRESTRIAL SENSITIVE ENVIRONMENT VALUES

Terrestrial Sensitive Environment	*Assigned Value*
Terrestrial critical habitat for Federally designated endangered or threatened species National Park Designated Federal Wilderness Area National Monument	100
Terrestrial habitat known to be used by Federally designated or proposed threatened or endangered species National Preserve (terrestrial) National or State terrestrial Wildlife Refuge Federal land designated for protection of natural ecosystems Administratively proposed Federal Wilderness Area Terrestrial areas utilized by large or dense aggregations of animals (vertebrate species) for breeding	75
Terrestrial habitat used by State designated endangered or threatened species Terrestrial habitat used by species under review for Federal designated endangered or threatened status	50
State lands designated for wildlife or game management State designated Natural Areas Particular areas, relatively small in size, important to maintenance of unique biotic communities	25

AIR PATHWAY CRITERIA LIST

SUSPECTED RELEASE				PRIMARY TARGETS
Yes	No	Unk		
	X		Are odors currently reported?	If you suspect a release to air, evaluate all populations and sensitive environments within 1/4 mile (including those onsite) as primary targets.
			Has release of a hazardous substance to the air been directly observed?	
	X		Are there reports of adverse health effects (e.g., headaches, nausea, dizziness) potentially resulting from migration of hazardous substances through the air?	
X			Does analytical or circumstantial evidence suggest a release to the air?	
			Other criteria? _____	
			SUSPECTED RELEASE?	

Summarize the rationale for Suspected Release (attach an additional page if necessary):

A suspected release to air is assigned on the basis of radionuclide survey results indicating gamma radiation levels elevated above background are present over portions of the site. The radionuclide survey was conducted during the site visit of November 4 and 5, 1992.

AIR PATHWAY SCORESHEET

Pathway Characteristics

Do you suspect a release (see Air Pathway Criteria List, page 211)? Yes X No ___

Distance to the nearest individual: 5280 - 10,560 ft

	A. Suspected Release	B. No Suspected Release	Reference
LIKELIHOOD OF RELEASE			
1. SUSPECTED RELEASE: If you suspect a release to air (see page 211), assign a score of 550. Use only column A for this pathway.	550		
2. NO SUSPECTED RELEASE: If you do not suspect a release to air, assign a score of 500. Use only column B for this pathway.			
LR =			
TARGETS			
3. PRIMARY TARGET POPULATION: Determine the number of people subject to exposure from a suspected release of hazardous substances to the air. 0 people x 10 =	0		
4. SECONDARY TARGET POPULATION: Determine the number of people not suspected to be exposed to a release to air, and assign the total population score using PA Table 8.	3		
5. NEAREST INDIVIDUAL: If you have identified any Primary Target Population for the air pathway, assign a score of 50; otherwise, assign the Nearest Individual score from PA Table 8.	0		
6. PRIMARY SENSITIVE ENVIRONMENTS: Sum the sensitive environment values (PA Table 6) and wetland acreage values (PA Table 9) for environments subject to exposure from a suspected release to the air.			
Sensitive Environment Type: National Park — Value: 100			
Sum =	100		
7. SECONDARY SENSITIVE ENVIRONMENTS. Use PA Table 10 to determine the score for secondary sensitive environments.	0.54		
8. RESOURCES	5		
T =	108.54		
WASTE CHARACTERISTICS			
9. A. If you have identified any Primary Target for the air pathway, assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor.	32		
B. If you have NOT identified any Primary Target for the air pathway, assign the waste characteristics score calculated on page 4.	—		
WC =	32		

AIR PATHWAY SCORE: $\frac{LR \times T \times WC}{82{,}500}$ = 23.15

PA TABLE 8: VALUES FOR SECONDARY AIR TARGET POPULATIONS

Distance from Site	Population	Nearest Individual (choose highest)	Population Within Distance Category: 1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	Greater than 1,000,000	Population Value
Onsite	0	20	1	2	5	16	52	163	521	1,633	5,214	16,326	52,136	163,248	—
> 0 to ¼ mile	0	20	1	1	1	4	13	41	130	408	1,303	4,081	13,034	40,811	—
> ¼ to ½ mile	0	2	0	0	1	1	3	9	28	88	282	882	2,815	8,815	—
> ½ to 1 mile	0	1	0	0	0	1	1	3	8	26	83	261	834	2,612	—
> 1 to 2 miles	3400[a]	0	0	0	0	0	1	1	3	8	27	83	266	833	3
> 2 to 3 miles	300[b]	0	0	0	0	0	1	1	1	4	12	38	120	376	0
> 3 to 4 miles	0	0	0	0	0	0	0	1	1	2	7	23	73	229	—

Nearest Individual = 0

Score = 3

PA TABLE 9: AIR PATHWAY VALUES FOR WETLAND AREA

Wetland Area	Assigned Value
Less than 1 acre	0
1 to 50 acres	25
Greater than 50 to 100 acres	75
Greater than 100 to 150 acres	125
Greater than 150 to 200 acres	175
Greater than 200 to 300 acres	250
Greater than 300 to 400 acres	350
Greater than 400 to 500 acres	450
Greater than 500 acres	600

PA TABLE 10: DISTANCE WEIGHTS AND CALCULATIONS FOR AIR PATHWAY SECONDARY SENSITIVE ENVIRONMENTS

Distance	Distance Weight	Sensitive Environment Type and Value from PA Table 6 or 9	Product
Onsite	0.10		
0 1/4 mi	0.025		
		National Park 100 x .0054	0.54
1/4-1/2mi	0.0054		

Total Environments Score = 0.54

[a] 2000 residents + 300 students + 100 daycare students + estimated 1000 workers

[b] 200 residents + estimated 100 workers

SITE SCORE CALCULATION

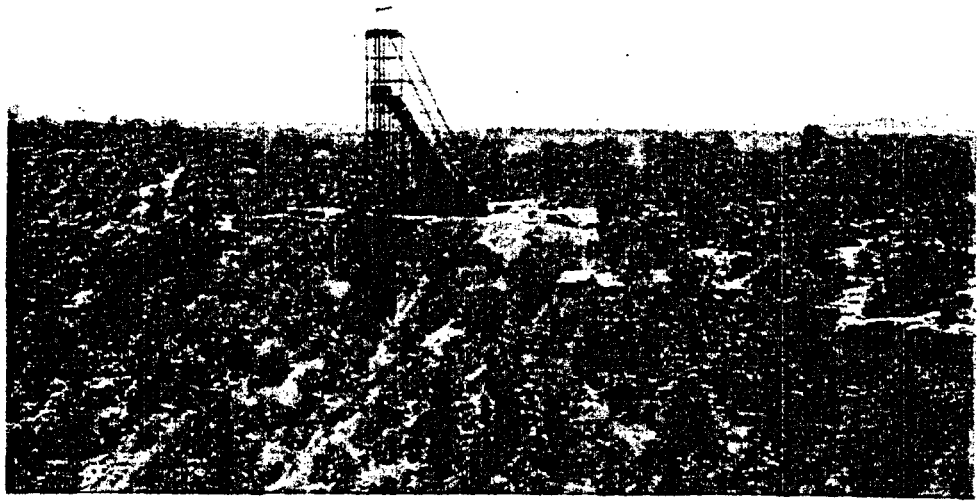
	S	S^2
GROUND WATER PATHWAY SCORE (S_{gw}):	—	—
SURFACE WATER PATHWAY SCORE (S_{sw}):	2.44	5.95
SOIL EXPOSURE PATHWAY SCORE (S_s):	13.60	184.96
AIR PATHWAY SCORE (S_a):	23.15	535.92
SITE SCORE:	$\sqrt{\frac{S_{gw}^2+S_{sw}^2+S_s^2+S_a^2}{4}}$	13.47

SUMMARY

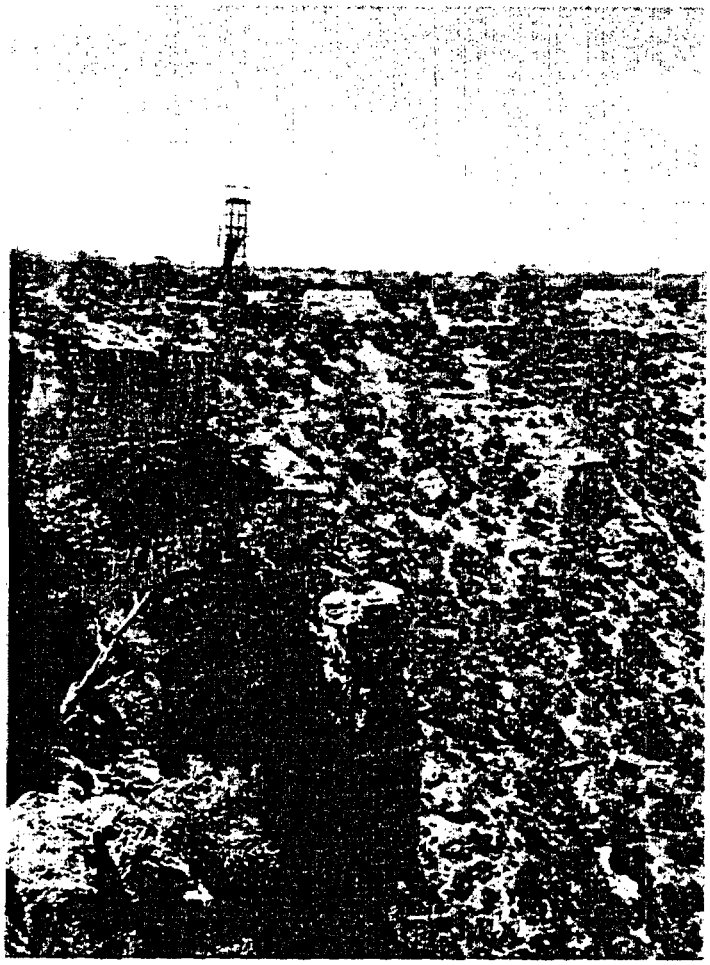
	YES	NO
1. Is there a high possibility of a threat to any nearby drinking water well(s) by migration of a hazardous substance in ground water?	=	X
A. If yes, identify the well(s). NA		
B. If yes, how many people are served by the threatened well(s)? NA		
2. Is there a high possibility of a threat to any of the following by hazardous substance migration in surface water?		
A. Drinking water intake	=	X
B. Fishery	=	X
C. Sensitive environment (wetland, critical habitat, others)	=	X
D. If yes, identify the target(s). NA		
3. Is there a high possibility of an area of surficial contamination within 200 feet of any residence, school, or daycare facility?	=	X
If yes, identify the property(ies) and estimate the associated population(s). NA		
4. Are there public health concerns at this site that are not addressed by PA scoring considerations? If yes, explain: Yes - There is concern regarding potential impacts to park visitors.	=	=

APPENDIX C

SITE PHOTOGRAPHS



South view of site from Hopi Point.

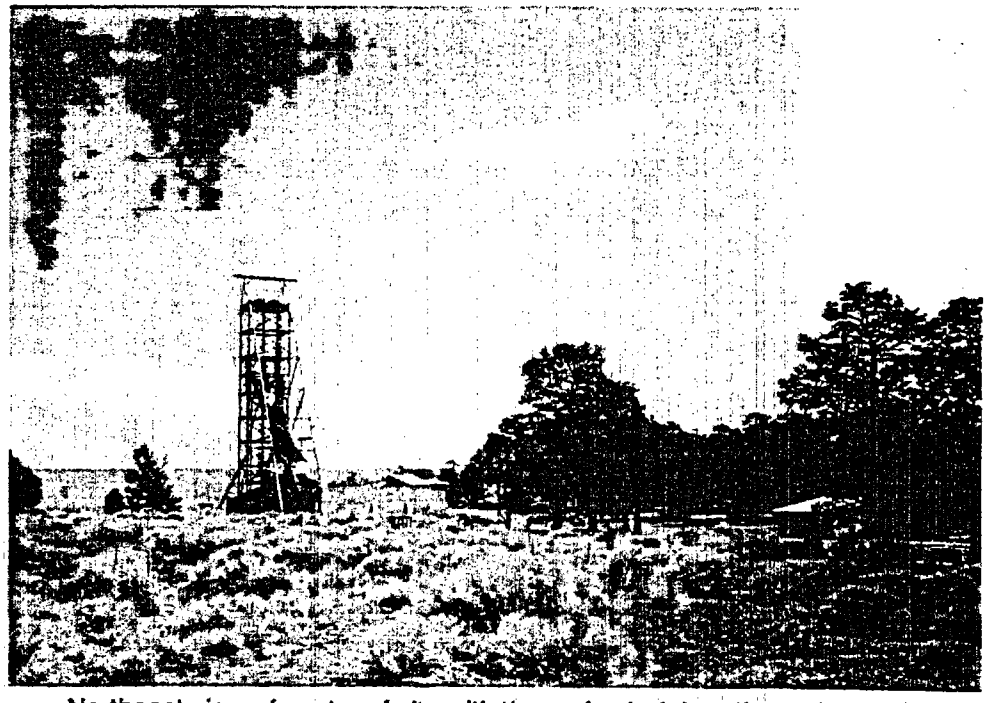


West view of site from Maricopa Point.

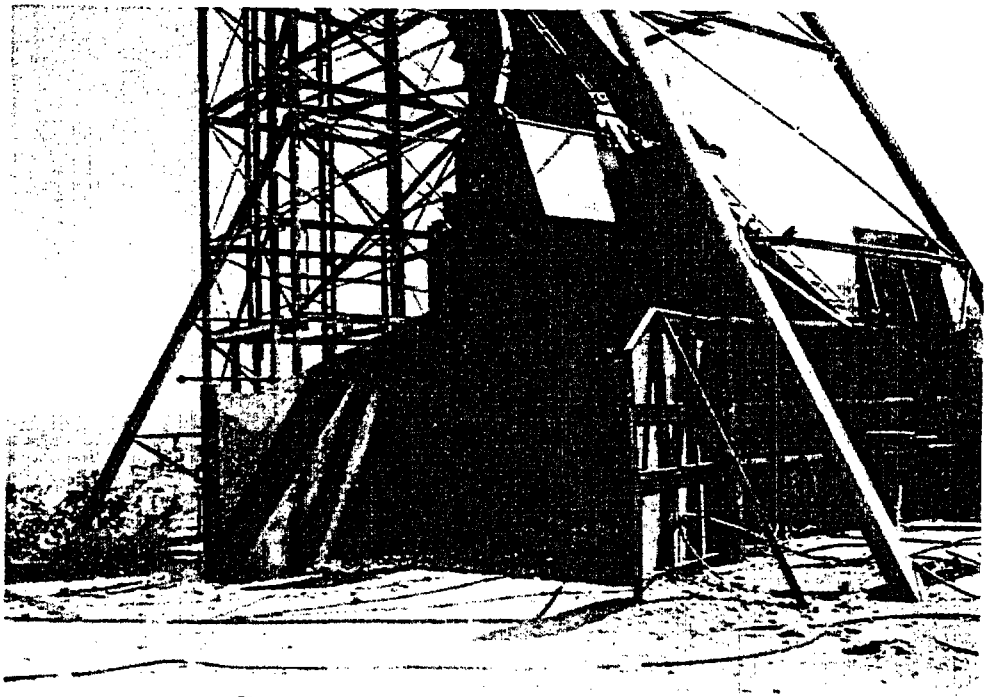
Aerial view of the "glory hole" at the lower mine area.

Aerial view of the "glory hole" and the lower mine area sheds.

Southeast view of area northwest of site with scattered tailings outside the site fenced area.

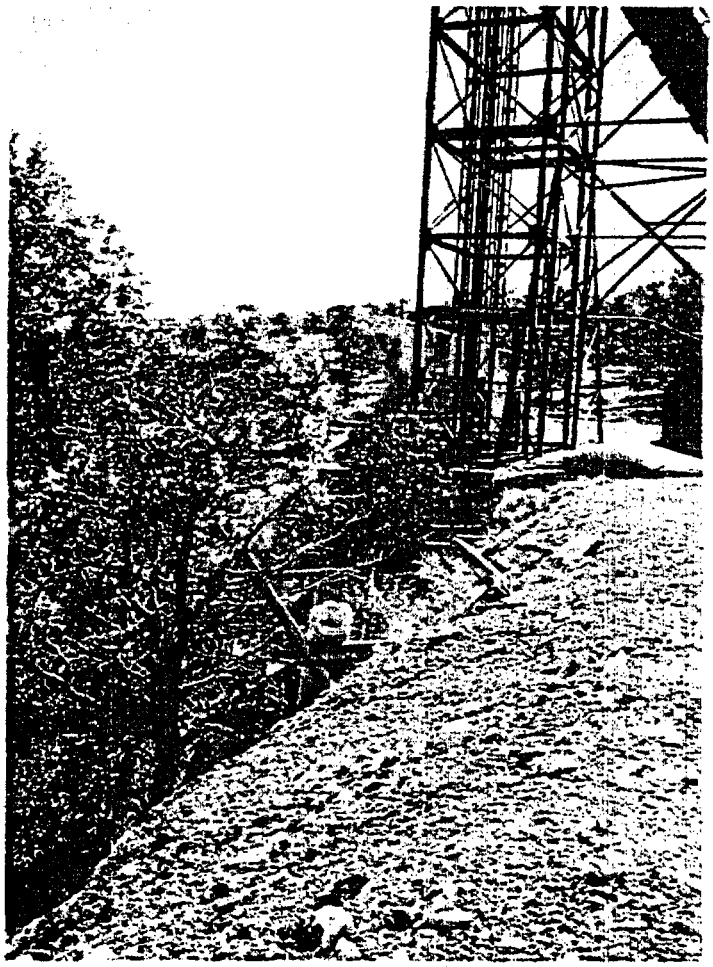


Northeast view of center of site with the main shaft headframe beyond.

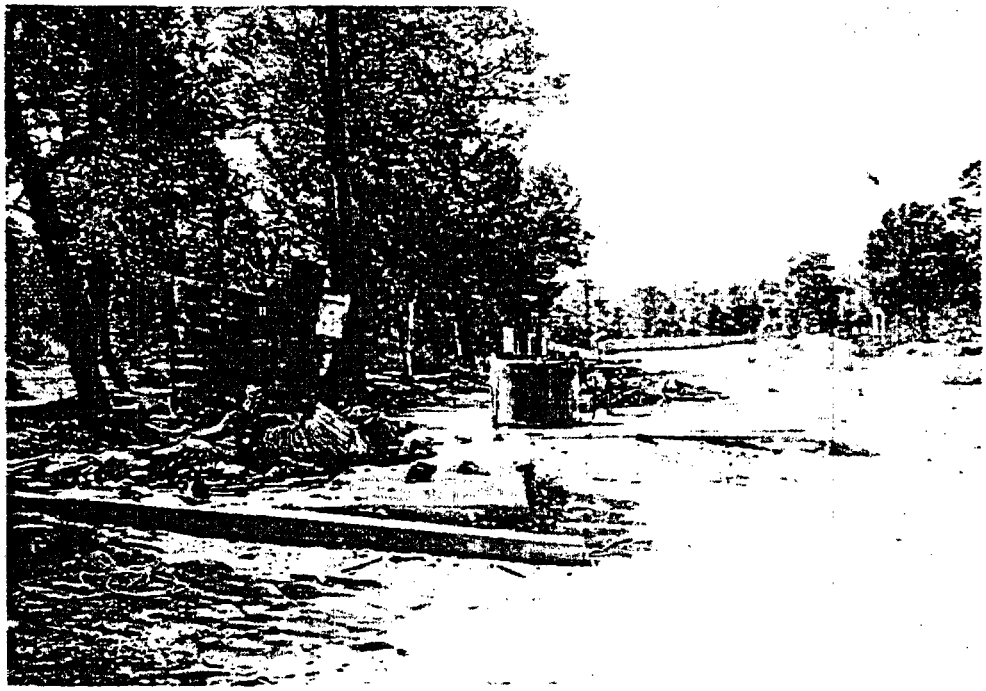


East view of tailings hopper at main shaft.

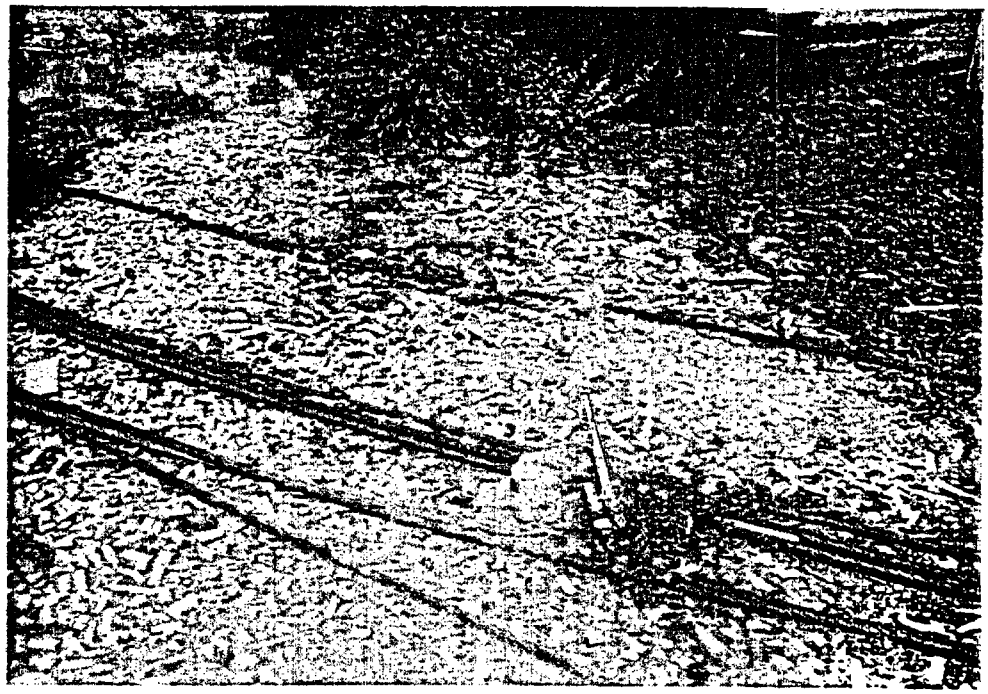
South view of concrete ore pad at south corner of site.



Southeast view of the main shaft headframe at the canyon rim.



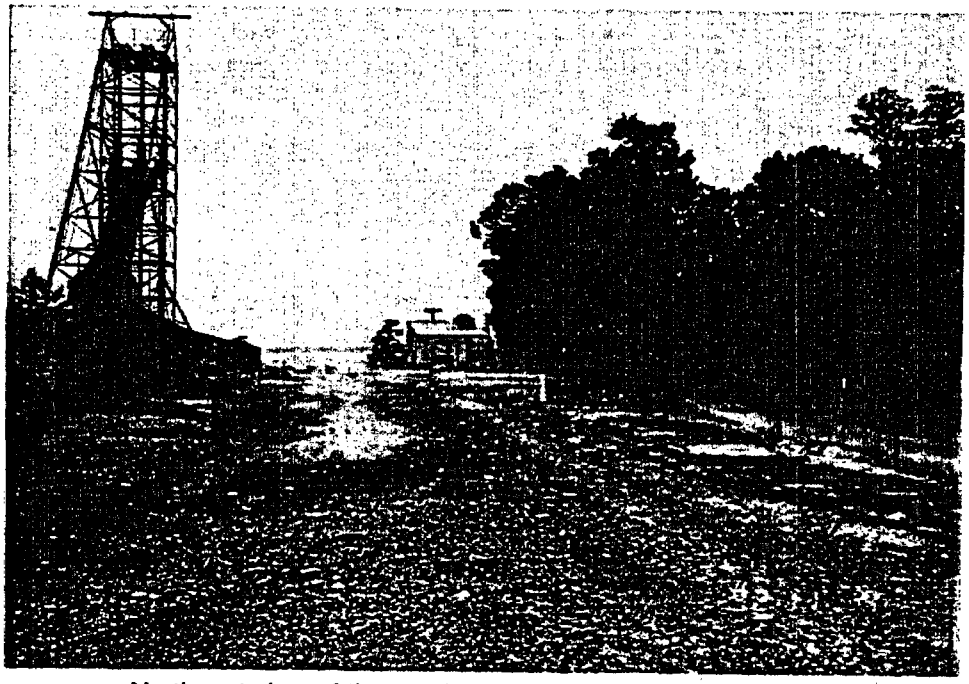
Southwest view of the southeast side of the site with the concrete ore pad beyond.



View of mine ore cores at site.

North view of area northwest of site with scattered mine tailings.
West corner of site at right.

Northeast view of northwest edge of site with the Canyon beyond.



Northeast view of the southeast side of site with scattered mine tailings on road.

Northwest view of the diesel underground storage tank fill spout covered with mine tailings. Northwest edge of site indicated by the fence beyond.

South view of diesel underground storage tank with west corner of site beyond.

APPENDIX D

SITE INVESTIGATION WORK PLAN

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SITE INVESTIGATION WORK PLAN

The following discussion outlines the site investigation work plan. The work plan is divided into three tasks. Task 1 includes preliminary activities to be performed prior to the field investigation. Task 2 delineates the field sampling and analysis program. Task 3 describes report preparation. The attached table presents a cost estimate for completing the following scope of work.

Task 1 - Preliminary Activities

HLA will attempt to locate aerial photographs of the site from the years 1930 to 1969, (during mine operation) and a recent aerial photograph of the site. Select photographs will be purchased to assess historic mine activities at the site and to prepare a base map for the sampling and analysis program to be performed under Task 2.

HLA will interview additional former mine employees to assist in interpreting the historic aerial photographs to select appropriate sampling and analysis locations. We will collect meteorological data from existing resources to assess wind speed and direction to be used during the risk assessment, as discussed in Task 3.

Once the historical aerial photographs and meteorological data are reviewed, HLA will develop a sampling and health and safety plan for the field investigation. This document will identify the specific activities to be performed during the field investigation, required equipment, sample collection and handling procedures, and specific health and safety issues for the personnel involved in the field investigation.

Task 2 - Field Investigation

The field investigation involves three primary activities: underground storage tank closure, radionuclide survey, and site mapping.

Underground Storage Tank Closure

ADEQ regulations require that before closure, the USTs need to be registered with the State. At that time, the closure process can proceed. In the field, HLA will assess the presence of a second UST by digging a shallow excavation in the suspected location. The USTs will be pumped dry of remaining fluid. The residual fluid will be placed in 55-gallon drums and stored onsite prior to recycling. Once the fluid has been removed from the UST and vapors are vented below explosive levels, the UST will be removed with a backhoe, visually inspected for leaks, and hauled offsite for disposal. The soil surrounding the UST will be visually monitored and analyzed in the field with a photoionization detector for the presence of petroleum hydrocarbon vapors. Soils with detected vapors will be excavated and stored onsite on plastic sheets for subsequent remediation and/or proper disposal. Soil samples will be collected at the base and sides of the excavations and analyzed to verify that petroleum hydrocarbon-affected soil has been excavated.

Radionuclide Survey

Previous site surveys have indicated that the radioactive waste material from the Orphan Mine is not confined to the present fenced area. The intent of the radionuclide survey is to assess the extent (i.e., area and depth) of radioactive mine waste at the Orphan Mine. The field survey will evaluate both the area at the canyon rim and the area surrounding the lower mine workings. Data obtained from the field survey will be used directly in the risk assessment process. The key components of the field survey include:

- general gamma radiation survey
- grid node gamma radiation survey
- grid node beta radiation survey
- subsurface beta and gamma radiation survey
- physical sample collection for laboratory analysis

General Gamma Radiation Survey: The land area surrounding the present fenced site at the canyon rim will be surveyed using a gamma scintillation meter. The purpose of this survey will be to assess the lateral extent of radiation above natural background and to assess the total area to be included in the next level measurements. Natural background conditions will be established with the gamma scintillation meter for locations within one kilometer of the site. Small flags, fluorescent tape, or wooden stakes will be used to mark this outer boundary.

Grid Node Gamma Radiation Survey: Once the total area with radiation levels above natural background has been identified, the entire area will be subdivided into square grids 10 meters on a side. Larger or smaller grids may be used depending on the size of the area and the results of the general survey.

A detailed gamma radiation survey will be made of the grided area using a gamma scintillation meter. The field personnel will take readings at the surface of the ground and at about 1-meter-high at each grid node location (i.e., at grid line intersections). The area within each grid square will be scanned by walking slowly over it and observing the uniformity of the readings and noting the location and magnitude of the highest readings. More detailed readings will be collected at the ground surface to define the areal extent of the highest readings.

Given the maximum public exposure of 0.002 rem/hr (2 mR/hr) identified in Section 3.3, areas that are identified in the gamma radiation survey that meet or exceed this value will be identified with a different color of flag, tape, or stake than was used to define the outer limits of the mine waste area. If the surface level readings are used to define the 2 mR/hr and higher areas, a conservative estimate of the area exceeding the hourly limit will be obtained. Total-body exposures that would be experienced by Park visitors and staff would be expected to be much lower than the readings at the ground surface.

Grid Node Beta Radiation Survey: Either concurrently or sequentially, the grid node survey will be repeated with a Geiger-Mueller (GM) counter. Two sets of readings will be collected, one with the GM meter cover open to measure total beta and gamma radiation, and one with the cover closed to measure gross gamma activity. Gross beta activity is determined by subtracting the gross gamma activity from the combined gross beta/gamma activity. As part of this exercise, gross gamma readings will be collected concurrently with the scintillation and GM meters to assess the level of agreement between the instruments.

Subsurface Radiation Measurements: Once the surface radiation survey data have been collected, the areas of highest surface radiation readings will be examined to assess locations for subsurface radiation measurements. Subsurface areas should be measured because areas with high radiation could result from the presence of subsurface material with high radiation. A few areas of low readings will also be examined because the potential exists for higher subsurface radiation readings in areas where low readings were encountered at the surface. The excavation equipment used to remove the USTs will be used to dig shallow trenches across a few of the identified areas. The trenches will likely begin and end in the areas of the low radiation readings and cut a cross section through the zone identified as having the highest surface readings. Because of the shallow depth underlying the bedrock, it is anticipated that the trenches will be no more than two feet deep and no wider than the width of a backhoe bucket. The excavated material and the lateral and vertical extent of the trench will be surveyed with the scintillation and GM meters to assess the vertical extent of the mine waste. The surface and subsurface data will be used to an estimate of the quantity of radioactive mine waste at the upper mine area.

Physical Sample Collection: Soil and rock samples will be collected from various surface and subsurface locations. Sample collection sites will include:

- outside the identified mine waste area
- inside the identified mine waste area
- areas with radiation readings above background but less than 2 mR/hr
- areas with radiation readings above 2 mR/hr
- areas inside the shallow trenches
- areas with the highest radiation readings

The collected samples will be submitted to a laboratory for gamma spectroscopy analysis. The primary purpose of the laboratory analyses will be to assess levels of uranium-238, thorium-230, and radium-226 in each sample. Other radionuclides may be identified using gamma spectroscopy methods if they are present in the samples at high enough levels.

Survey of Lower Mine Workings: Two members of the field team will hike down to the lower mine workings to perform a radiation survey of the area surrounding the "glory hole" and adit. If surface water is present in the lower mine area, a sample will be collected for uranium analysis. A less detailed survey than was performed at the upper mine area will be made at this location. It is intended the team members will complete the survey and make the round-trip hike in one day.

Site Mapping

Upon completing the investigative activities, the horizontal and vertical position of each marked location (flag, stake, excavation etc.) will be surveyed and tied into a site coordinate system by a registered land surveyor. These data and other site observations will be used to develop a detailed base map for the site. Field radiation survey results (beta and gamma) will be plotted on the base map for use in the risk assessment.

Task 3 - Project Report

A draft report will be prepared and submitted to the NPS for review. The report will include documentation of the collected data, conclusions, and recommendations for additional work if required. The report will be revised based on the NPS comments and submitted to the NPS as a final document.

TABLE D-1. SITE INVESTIGATION
DIRECT LABOR BUDGET ESTIMATE
ORPHAN MINE SITE INVESTIGATION
GRAND CANYON NATIONAL PARK

TASK	ASSOCIATE SCIENTIST	SENIOR SCIENTIST	PROJECT SCIENTIST	STAFF SCIENTIST	TECHNICAL EDITOR	WORD PROCESSOR	CLERICAL	GRAPHICS	TOTAL
Task 1 - Preliminary Activities									
Geologic summary	8					2			10
Review applicable state regulations	16		16			4			36
Aerial photo survey	16			16		4			36
Task 2 - Field Investigation									
Sampling and analysis plan	4		8	16	4	8			40
Health and safety plan	2		4	16	4	8			34
Underground storage tank closure	8	16		36					60
Radionuclide survey	48	48				8	4		108
Task 3 - Report	15	25	20	0	5	12	8	15	100
Total hours	117	89	48	84	13	46	12	15	424
Hourly rate ($)	95.50	63.66	58.13	49.14	35.99	40.13	35.99	35.99	
Subtotal cost ($)	11,174	5,666	2,790	4,128	468	1,846	432	540	27,043

Note: Eight field days with two people are scheduled for Task 2.

TABLE D-1. SITE INVESTIGATION (continued)
OTHER DIRECT BUDGET ESTIMATE
ORPHAN MINE SITE INVESTIGATION
GRAND CANYON NATIONAL PARK

Task 1 - Preliminary Activities	
Aerial Photo Survey	
8 Photographs @ $50	$400
Task 2 - Field Investigation	
Sampling and Analysis Plan	
Computer time 8 hours @ $25/hour	$200
Health and Safety Plan	
Computer time 8 hours @ $25/hour	$200
Underground Storage Tank Closure	
Laboratory fees 5 samples @ $100 each	$500
Equipment rental	$400
UST Excavation and disposal cost (assuming no over-excavation of affected soil)	$6,000
Radionuclide Survey	
Equipment rental (radiation meters) 7 days @ $90/day	$630
Personal protective equipment (coveralls, boots, TLDs, etc.)	$800
Air travel - 2 roundtrips @ $800	$1,600
Per diem/hotel 16 days @ $100	$1,600
Rental car 8 days @ $50/day	$400
Laboratory analyses 20 samples @ $100	$2,000
Surveyor (To be determined)	
Miscellaneous (estimate $500)	$500
Task 3 - Report	
Computer time 25 hours @ $25	$625
Reproduction	$200
Total cost	$16,055

TABLE D-2. RISK ASSESSMENT
DIRECT LABOR BUDGET ESTIMATE
ORPHAN MINE SITE INVESTIGATION
GRAND CANYON NATIONAL PARK

TASK	ASSOCIATE SCIENTIST	SENIOR SCIENTIST	PROJECT SCIENTIST	STAFF SCIENTIST	TECHNICAL EDITOR	WORD PROCESSOR	CLERICAL	GRAPHICS	TOTAL
Task 1 - Risk Assessment	75	40	150	50	16	28	8	18	100
Hourly rate ($)	95.50	63.66	58.13	49.14	35.99	40.13	35.99	35.99	
Subtotal cost ($)	7,163	2,546	8,720	2,457	576	1,124	288	648	23,522

OTHER DIRECT BUDGET ESTIMATE

Task 1 - Report	
Computer Time 56 hours @ $25/hr	1,400
TOTAL	$24,922

DISTRIBUTION

8 copies: National Park Service
Denver Service Center
12795 West Alameda Parkway
P.O. Box 25287
Denver, Colorado 80225
Attention: Ms. Shelly Wells

QUALITY CONTROL REVIEWER

Robert A. Zimmer
Associate Environmental Scientist